unasylva

an international journal of forestry and forest industries

1977
vol. 29 no. 117

FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

unasylva

an international journal of forestry and forest industries

vol. 29 no. 117

T.M. Pasca, Editor, Forestry Department, FAO

Unasylva is published quarterly and is available in English, French and Spanish editions through subscription. Price: one year, $8.00, payable to the Distribution and Sales Section, FAO, Vial delle Terme di Caracalla, 00100 Rome, Italy. Orders in local currencies may be placed with any of the FAO sales agents listed on the inside back cover.

Cover: A roll of paper
design by Utta von Beyme

The political economy of pulp and paper

K.F.S. King

The reason why I selected the pulp and paper industry as the subject for this address is that it is apparent to me that today this industry exerts a considerable psychological attraction for governments of developing countries. Almost every developing country with a modicum of forest resources, or with what appears to it to be a sizable market, has approached the Food and Agriculture Organization with the request that they examine the possibility of establishing some type of pulp and paper factory, of one kind or another, in that country.

This is not surprising. The developing countries have been told, with some truth, that such an industry can save or earn foreign exchange; that it can introduce local personnel to a relatively sophisticated technology; that it has high forward, backward, and lateral linkage indices and can therefore ramify and influence many other sectors of the total economy; and that it is capable of employing relatively large numbers of workers, technicians, and scientists, the first group particularly in the forest. They believe that the industry yields high profits. In short, they consider that the establishment of a pulp and paper industry in their countries would provide them with a basis for sustained national economic development.

And they are not wrong, in theory. The problem is to distinguish between theory and reality. The problem is to decide in what circumstances these benefits which are inherent in the pulp and paper industry, indeed, some may say, which are a part and parcel of the entire forest industry sector, may be realized. The problem is to choose the correct strategy for the development of this industry in the less industrialized countries.

But first a few remarks concerning one phrase in the title of my address. I have deliberately chosen the term "political economy" even though some may consider it to be outmoded and discarded. I have interpreted it to mean "economic thought seen as a branch of statecraft."

I confess that I was just a bit influenced in my choice of this phrase by the fact that I knew that I was going to deliver this address in Germany. As you are aware, during the 19th century, German economists were somewhat dissatisfied with the "deductive" methods of the English "classifical" school, and evolved the "historical" school. Now in my opinion, neither the "deductive" method nor the "historical" method, when applied alone, is entirely satisfactory. It was a German, Wilhelm Roscher, who provided the vital and necessary link between the "classifical" and "historical" schools of thought. In his *Outline of political economy according to the historical method*, he argued strongly, and to my mind convincingly, that there was need to infuse the study of historical facts and opinions into economic analysis. It is this approach that I wish to follow today. I am of the opinion that it is impossible to properly understand the operations of most sectors of any national economy without a full appreciation of the historical factors which have shaped the sector.

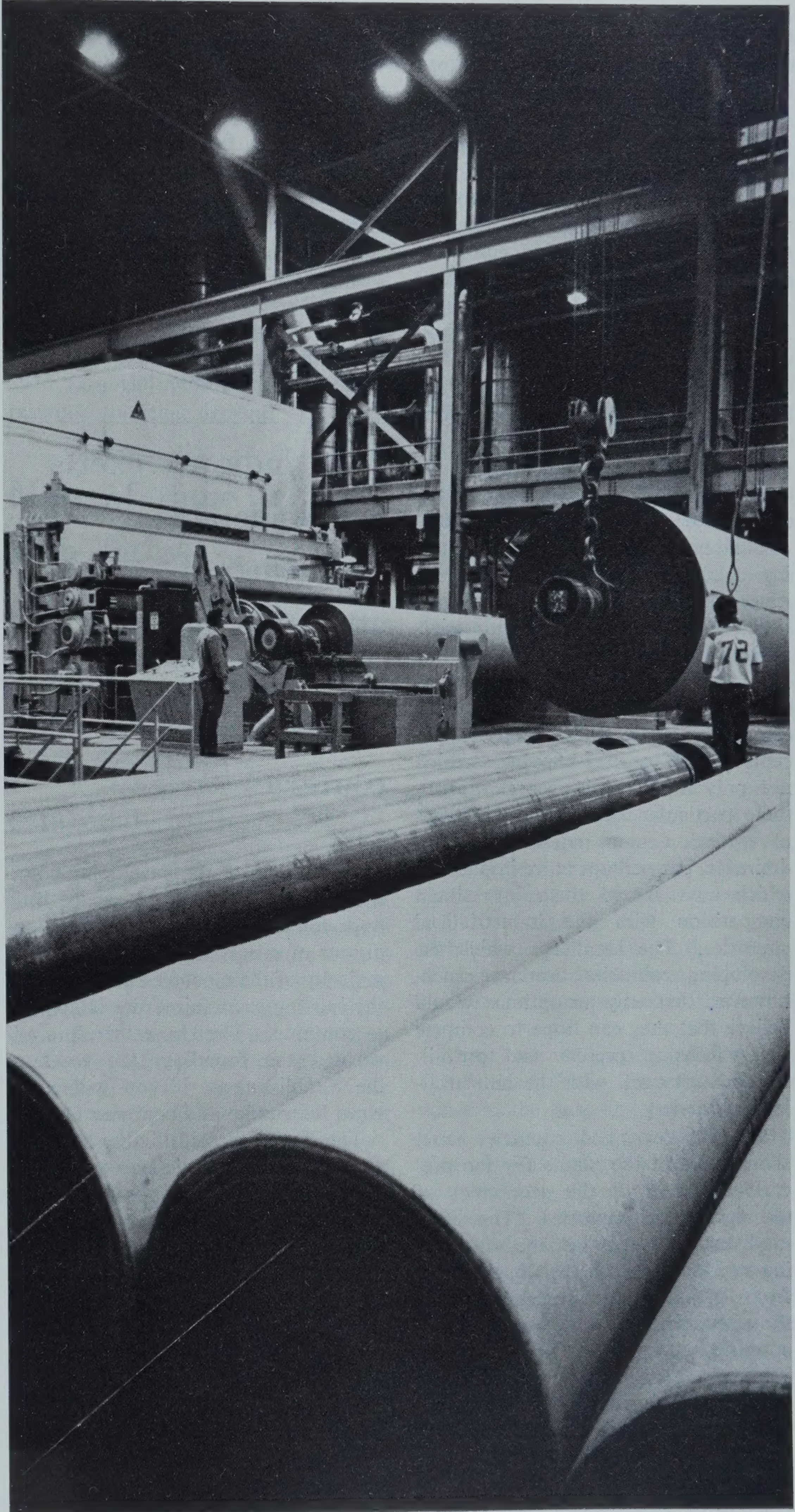
However, my main purpose in choosing the old term "political economy" is that I desired to emphasize that in the formulation of develop-

K.F.S. King is Assistant Director-General in charge of forestry at FAO. He delivered this address in May 1977 at the *Bundesforschungsanstalt für Forst- und Holzwirtschaft*, Hamburg/Reinbek, the principal forestry and forest industries research institute of the Federal Republic of Germany.

mental policies for the pulp and paper industry, and in examining the economics of that industry, individuals, or groups of individuals, or corporations, which influence governments cannot be ignored. I desired to stress, also, the inter-connections which exist, and will continue to exist between, for example, the fiscal and monetary policies of governments and the present and future structure and development of this subsector of the world's forest industries. And I intended to draw attention to the fact that very few economic decisions are today left to be solved in the market place. Even in the industrialized countries, government interventionist policies are to be felt in almost every sector of the national economies, not least in the forest industries sector, even though homage is paid to the principle of free enterprise. It is my contention that in the developing, non-industrialized countries, such interventionist policies are even more necessary, and that in considering the establishment of a single pulp and paper enterprise its influence on the entire national economy should be considered. As important as the historical factors which have shaped the sector, are the political factors within which it operates and will continue to operate.

Elsewhere [1] I have described the legacy which was left in the developing countries when the proconsular classes departed, during the period which began at the end of the last World War, and which saw the decline of political imperialism. I have listed as legacies the lack of adequate infrastructure, the dearth of training institutions, and the dependence of the economies of the former colonies on the production, for export, of primary raw materials. I have pointed out that there was created in the minds of the peoples of the colonies a dependency syndrome. I have stressed that, by and large, very few industries had been established and that the basic pre-conditions for industrial development were not available in the colonies, in the developing countries, themselves.

[1] KING, K.F.S. (1975). *The Forestry Sector and Economic International Relationships.* Weyerhauser Lecture Series, University of Toronto.



A LARGE EUROPEAN PAPER MILL

for the third world, right industry, wrong scale

Many analysts are convinced that the plight of the less industrialized countries has become more acute over the last decade or so. High rates of unemployment, slow rates of economic growth, adverse balance-of-payments positions and debilitating external debt burdens are but a few of the problems which are almost common to, and chronic in, the developing countries. In addition to these, there are those which are caused directly by external forces, most notable of which is imported inflation.

I do not wish to imply that all these ills are caused by the actions of the developed countries. Indeed, I am certain that many of the problems of the developing countries, such as the inequitable distribution of incomes, can and must be solved by the developing countries themselves. I am positive, also, that several of their difficulties are created by the less industrialized countries themselves in that they have tried to adopt, willy nilly, northern hemisphere styles of living, northern technologies, and northern concepts of welfare and happiness which not only are not always relevant to their particular situations and stages of evolution, nor indeed inherently desirable, but perhaps more important, which have forced them into direct competition with the industrialized countries. The handicaps which the developing countries bear are such, however, that only an optimist would believe that they can hope to compete successfully, in present and prevailing circumstances, with the industrialized countries.

But the developed countries must share some of the blame for the precarious nature of the economies of the developing countries. The commodities exported by the developing countries to the developed suffer from greater price instability than those exported by the industrialized countries. Moreover, in many developed countries there are restrictive trade measures which effectively prohibit manufactured and processed articles, which emanate in the developing countries, from competing effectively in developed countries. One consequence of this is, of course, the accrual of the value added, through processing, in the already rich developed countries and not in the poor developing countries. In addition, the developed countries have adopted support policies which bolster and maintain inefficient producers (in the Western, capitalist, free-enterprise sense of the term) thus enabling them to undersell the producers of the developing countries.

This list of practices which hamper the economic development of the less industrialized countries is not exhaustive. I suggest, however, that it is sufficiently long to make the point that we are all responsible.

This industry exerts a considerable psychological attraction for governments of developing countries.

The leaders of the developing countries are aware that there can be little hope for the amelioration of the conditions of misery and want, which the majority of their peoples experience, if the existing economic order is allowed to continue. They have therefore advocated the founding, the creation, the establishment, if you will, of a New International Economic Order.

The main theme of the New International Economic Order is the restructuring of international economic relations in such a way as to make it feasible for countries of the Third World to initiate or accelerate internally located and relatively autonomous processes of growth, diversification and integration. These processes are to be designed in such a way as to enable Third World countries to mount effective attacks on emerging internal crises, principally mass poverty, mass unemployment, and growing food deficits. Emphasis is placed on ensuring, through trade and aid, increased net inflows of real resources to the developing countries.

It seems evident to me that the ultimate objective of the New International Economic Order, which is the development of the peoples of the Third World, and in particular those who bear the brunt of the inefficiencies and inadequacies of the world's leaders, will not be attained if conventional theories, policies and instruments of economic development are continued to be employed. They have failed in the developing countries in the past. They are failing now. New concepts and approaches must therefore be applied.

It is against this background of turmoil, depression, poverty, misery, want and injustice, on the one hand, on the other, a new concept which appears to provide some hope for the " feeble " of this world, that I now wish to examine the political economy of the pulp and paper industry.[2]

In 1975, the consumption of paper by developing countries, which accounted for about 50 percent of the world's population, was approximately 11.5 million tons, or 8 percent of the word's production of paper in that year. The per caput consumption per year in most of these countries was less than 10 kg. In Latin America, where there is a specific demand for packaging paper and for paper board, the average annual consumption was 25 kg per caput. In contrast, in the highly industrialized economies, on the average, annual consumption was 200 kg per caput.

Eighty-four percent of the paper consumed in the United States is utilized by intermediate industries as part of the goods and services which they provide; 9 percent is for personal consumption; and businesses and government consume 7 percent. Research into paper consumption patterns within the U.S. has indicated that paper is not an important cost element in the intermediate industries. For example, in the packaging industry,

[2] This analysis relies heavily on FAO (1976) — *The North American paper industry.* Working Paper No. 17. PPIDP; FAO (1977) — *An analysis of the growth potential for the pulp and paper industries sectors in developing countries.* PPIDP; and FAO (1977) *Pulp and paper in the perspective of developing countries.* Working Paper No. 19. PPIDP.

which alone consumes 55 percent of the paper utilized in the U.S., the cost of paper is seldom higher than 1 percent of the particular product. In newspapers and journals, especially those with wide circulations, the relative cost of paper, though substantially higher than for packaging, is still not a major element in the total cost structure of the final product. The same pattern may be discerned in Europe which consumes 30 percent of the world's paper production.

Thus, like petroleum used to be, paper is regarded in the industrialized market economies as a low-cost commodity that is to be taken for granted in the modern life style. Indeed, its contribution to the overall cost of living, compared to all other inputs, is so small that its relative insignificance encourages wasteful consumption. To cite one example: in North America, where the recovery of paper for recycling is as high as 20 percent, 46 million tons were discarded as waste. This is equivalent to four times the total annual paper consumption of all the developing countries taken together.

Since 1969 the consumption of paper and paper board has increased at a rate of between five and six percent per annum. A recent assessment made by FAO suggests that, because of the current world economic situation, the rate of growth in the foreseeable future will be between two and three percent per annum overall, with lower rates of growth for specific products, such as newsprint.

However, because the consumption of paper in developing countries is now so low, the future rate of growth is likely to be higher than at present. As I have said, in 1975 the developing countries consumed 11.5 million tons, and it is forecast that by 1990 they will utilize between 28.75 and 37.5 million tons of paper per year. It should be noted, however, that these forecasts suggest that Latin American markets will consume about 55 percent of all the paper utilized in developing countries.

In that same year, 1975, total world consumption of paper amounted to 142 million tons, 92 percent of which was consumed by the more industrialized world.

The world's capacity, in 1975, to produce pulp was estimated to be 136 million tons; its capacity to produce paper and paper board, also in 1975, was rated at 175 million tons. However, in 1975 actual production was somewhat below capacity, 109 million tons of pulp and 136 million tons of paper being produced, of which some 95 percent was manufactured in developed countries. Although a substantial surplus of capacity over consumption existed in 1975 for both pulp and paper, this was reduced in 1976 through increased utilization in response to rising demand.

Most of those with forests, or what look like good markets, have asked FAO to help them establish mills.

So much for the consumption and production statistics. Let us now have a closer look at the structure of the industry. We will confine ourselves to the North American and European regions, because between them they dominate both production and consumption.

The main points about the paper industry of North America are: first, it is bigger than that of any other region in the world, possessing as it does 40 percent of the world's capacity; second, that it is entirely self-sufficient for its raw material requirements; and third, that it sells more than 90 percent of its output within the region.

Moreover, the paper industry in North America is more elaborate, and more sophisticated technically in its range of processes and end products than anywhere else in the world.

If the North American producers, Canada and the U.S.A., are compared, significant structural differences emerge. Canada's paper industry is the smaller, possessing only 20 percent of the continent's capacity. In addition, it exports about 75 percent of its pulp and paper production, of which some 70 percent go to the U.S.A., the rest being shipped to other areas, mainly Europe and Japan. In contrast, the U.S.A. has little external trade in these commodities, as its imports of Canadian pulp and paper are offset, to some extent, by its exports, mainly to Europe, and to a lesser extent to Japan and other regions.

The main Canadian exports are pulp and newsprint, and the chief U.S.A. exports are linerboard and other container boards. The U.S.A. imports about 60 percent of its newsprint, and about seven percent of its pulp requirements from Canada. There is little trade in converted products.

A significant trend of the North American pulp and paper industry, during the last two decades, has been the move toward greater integration. For example, the Weyerhauser Company has integrated backward toward the resource, while other companies have established forward linkages with various types of paper and paper board conversion industries. Still other companies have merged themselves, or have been merged, with quite dissimilar types of corporations, presumably to spread the risks, and to absorb losses which occur in the troughs of the cyclical fluctuations which are such a significant aspect of the industry.

There are 450 companies in the U.S.A. and 70 in Canada that are active in the pulp and paper business. They range from large multi-national giants to small family-owned one-mill operations.

The top twenty companies in the pulp and paper industry taken as a whole in North America account for about 65 percent of the region's total production. In this respect, they are less dominant than the top 20 companies in other basic industries. For example, in the petroleum, coal, primary metals, chemical and rubber industries, the top 20 companies account for more than 90 percent of production. Nevertheless, there is a growing tendency for still greater concentration of control in the pulp and paper industry.

However, in pulp production, the top 20 companies account for nearly all of the output. Non-integrated paper mills are therefore dependent on the leaders of the industry for their raw materials.

The large paper companies in North America all operate in the international arena — if only in export marketing when they do not have actual operations abroad. The most important overseas area is Europe. This region is followed closely by Latin America and then by Japan. Most companies operate in more than one overseas country — some in as many as eight.

However, except for Container Corporation, in no case do overseas operations amount to more than 25 percent of a company's business, although in some cases export sales might exceed this proportion. MacMillan Bloedel and Weyerhauser appear to be the biggest exporters: exports amounting to 40 and 30 percent respectively of their recent sales. Union Camp and International Paper follow in the 20 to 25 percent range.

The big companies are all managed by highly professional and experienced managers and are, in the main, owned by tens of thousands of shareholders.

At the lower end of the scale of size, the leading companies will typically have 40 to 60 plant operations, employ 15 to 20 thousand workers, have paper-making capacity of just under one million tons per year, and have sales of just under $1 000 million. The bigger companies will have from 150 to 200 plant operations, employ from 30 to 50 thousand workers, have paper-making capacity of about three million tons per year (the capacity of International Paper is seven million tons per year), and have sales in the $2 000 million to $3 000 million per year range. Europe, with 12% of the world's population, consumes about 30 percent of the world's paper production. The continent's present production of paper is about 45 million tons, which not only makes Europe self-sufficient in paper, but permits it to be a net exporter of about 500 thousand tons.

However, Europe is a net importer of some types of paper: newsprint (450 thousand tons) and paper board (740 thousand tons).

It is a net exporter of printing and writing paper (1.7 million tons).

Europe's production of pulp, in 1974, was 29 million tons. It was found necessary, however, to import 3.25 million tons of wood pulp in order to meet the excess in demand for pulp which has been, over the last ten years or so, a constant feature of the subsector. The capacity of Europe's pulp mills was estimated to be 33.4 million tons in 1975. It has been forecast that this will increase to 39.1 million tons in 1980. The region's capacity to produce paper was 52.2 million tons in 1975. This is expected to rise by 10.4 million tons by 1980.

FAO seeks conditions for establishing small- to medium-size mills in developing countries.

The average production of a European pulp mill is 53 400 tons. The largest production units are to be found in the Nordic countries where the average production is about 100 000 tons per year. The largest individual unit is the Husum mill in Sweden which is owned by Mo and Domsjö. It produces, on average, 492 000 tons of sulphate pulp each year.

In the European Community there are 164 pulp mills, of which 143 are integrated with paper mills; 57 of the 89 paper mills that are to be found in Sweden are physically integrated. Many of the remainder, however, may be considered to be also integrated because they belong to larger pulp and paper companies and supply their pulp to their parent companies' paper mills. Fifty of the 58 mill units in Finland are integrated.

In almost all European countries pulp mills are increasing in size. If Sweden is taken as a typical example, the average mill capacity has increased from 44 000 tons in 1960 to 123 000 tons in 1975. The sulphate mills are the largest, with an average capacity of 197 000 tons per year.

Although the largest European pulp and paper mills are located in the Nordic countries, it is in England that the paper companies with the largest turnover are to be found. These are Bowater Corporation and Reed International. The Swedish companies, Svenska Cellulosa and Stora Koppaberg, are in third and fourth place, respectively.

Bowater and Reed have expanded into other fields to such an extent that they cannot now be counted solely as forest industries companies. Only 42 percent of the turnover of Bowater's and 55 percent of Reed's, in 1975, originated from sales of pulp, paper and converted paper products. Indeed, the same story applies to Stora Koppaberg, which in 1975 obtained only 41 percent of its sales from its forest industry division.

Svenska Cellulosa (with 80 percent of its sales from forest products) and Wiggins Teape, the United Kingdom company, with its entire turnover coming from paper and paper products, are the exception to the general rule that the top paper companies are parts of conglomerates. Here, the North American pattern is repeated. Several of the companies have grown large, not through increasing their output of forest products, but through extension into large converting and trading operations, and also through entering into entirely new fields of activities.

There seems to be a growing tendency for European companies to establish links with North American companies operating in North America, either through the forging of partnerships with existing mills or through the establishment of new mills. In the same manner, several North American forest industry companies are listed as partners in major European pulp and paper enterprises. In addition, some have substantial interests in the tertiary conversion industries.

There is also increased cooperation, if one is permitted to use a euphemism, among European companies and countries. This has long been the case in the Nordic countries, but most recently the tempo has quickened and

the spread widened. To quote one example: the building of Undland Papier Mill in the Federal Republic of Germany by two Finnish companies — Kymin Kymenne and Kaukas.

The other characteristics of the North American segment of the industry apply, in varying degrees, also to Europe, except with regard to the vital question of wood supply. All the estimates available in the Food and Agriculture Organization indicate that even with improved and more efficient methods of production, harvesting and conversion, Europe would still be short of wood, for almost the whole range of wood products, well into the next century.

What has our analysis revealed? It has shown that the pulp and paper subsector, as it obtains in those regions in which it has been most successful, has certain characteristics:

- It is generally big in scale, and there is a growing tendency to increase mill size.
- To survive periods of recession or down-turn it often forges links with companies which are totally outside the forest industries sector — in other words, it diversifies and becomes a part of conglomerates.
- It is extremely capital intensive — this is a function, mainly, of the large mill sizes.
- It demands a high level of technical skill and managerial competence.
- It employs competent researchers in its continuous quest for improvements in technology, general efficiency and marketing.
- The American market is, to all intents and purposes, self-contained and offers little hope in the near and in the foreseeable future as an outlet to new producers.
- The top 20 North American companies produce a sizable proportion of the total output of pulp and paper in those countries.
- The top 20 North American companies produce nearly all of the pulp consumed in the region.
- Only in Europe are there possibilities for the sale of " new " pulp, but this may be more apparent than real, because of the beginnings of a tendency for European ownership to merge with North American, and because of the favourable wood-supply position on the North American continent.
- The bigger companies are squeezing the smaller ones out of business.
- There appears to be a tendency for the amalgamation of producers' interests, although strong anti-trust laws, both in the U.S.A. and in Europe, effectively prevent collusion.

What are the lessons for the developing countries? It seems obvious that the developing countries cannot hope to follow the patterns of growth and development which have emerged from our analysis of the pulp and paper sector in the United States and in North America. Nor is it perhaps desirable that they do. But yet it is almost certain that these developing countries will be faced with a shortage of paper if they do not take steps now to provide themselves with the production capacity they will need in the years ahead.

Let me illustrate the point I wish to make by referring to those countries of southeast Asia which comprise the Association of Southeast Asian Nations - ASEAN: Indonesia, Malaysia, the Philippines, Singapore and Thailand. I have chosen this group to illustrate the problem because it seems to me that the effects of a shortage of paper could be most dire in this region. Forecasts of paper consumption for the area suggest that the total paper requirements are likely to double by 1985 and that by the year 2000 they could be more than five times greater than the 1974 consumption.

If nothing is done, this would, of course, mean a drain on the region's scarce foreign exchange resources. This, apart from the positive linkage effects which the establishment of a pulp and paper industry could have on the general economy and the absorption of a proportion of unemployed labour.

Aware of the probable dangers to the economies of the developing countries if there are not adequate supplies of paper, aware also of the benefits which can accrue to these countries through the establishing of these industries, but aware, still further, that if the habits and practices of the industrial world are transferred lock, stock and barrel, to the developing countries, their economies could be wrecked, the Food and Agriculture Organization has attempted, during the last two years, to formulate new methods of approaching this problem. Our present philosophy has been evolved through the realization that, in any case, for whatever reason, large mills were not being established in the developing countries; that if they were to be established, their establishment, with the high capacities recommended, would in many cases be against the developmental needs of many developing countries, and would be detrimental to their best interests; and that the normal price which would have to be paid by the non-industrialized countries through continued dependence on the industrialized countries would be considered by some governments to be too high.

Many developing countries cannot afford, even to borrow, the large amounts of capital that are needed to establish pulp and paper mills of capacities of 750 to 1 000 tons a day. These are the sizes which the international clubs of consultants continually recommend. In at least 33 percent of the cases which we have examined in FAO, the establishment of such large mills would result in one pulp and paper mill, of the sizes to which I have referred, making a contribution of at least 40 percent to the gross national product of the countries. Such great reliance on one commodity would be, in most cases, undesirable. It is particularly so in the pulp and paper industry in view of its notoriously cyclical performance. It would be even more reprehensible if the final product were pulp for which there were no tied, no secure markets. Unfortunately, this is the type of mill which has often been recommended.

Because of these considerations, FAO has concentrated on the potential for the establishment of small- to medium-scale integrated pulp and paper mills designed to meet the domestic or regional market requirements of developing countries. Particular attention has been given to the minimum size of an economically viable mill that is capable of producing the required range of paper goods from local fibre.

We have not chosen, deliberately, to ignore the well-established principle of the economies of scale. We are of the opinion, however, that the principle is not well understood by many of the engineers and accountants who are concerned with the development of pulp and paper industries in the developing, and indeed in the developed, countries. This is not the place to examine the issue in detail. I wish merely to state here that the optimum size of a mill is not necessarily the same in different countries and under different conditions; that in deciding on mill size the specific objectives of economic development of a country are of great importance; and that some industries might be considered by some countries as vital and strategic infrastructure. In short those decisions on scale cannot be made by the consideration of only one factor. Indeed they should not be.

Be that as it may, integrated mills, based upon a chemical pulp line to produce between 100 to 200 tons of cultural and/or industrial paper grades per day, have been shown to be acceptable, under certain conditions, with investment costs, at 1976 prices, of up to about $120 million. The continued adaptation of technology has, however, advanced to a point at which it is now possible to consider the construction of small-scale integrated plants based upon thermo-mechanical or chemi-thermo-mechanical processes to produce a restricted range of cultural paper grades on slow-speed paper machines. These plants can have a paper output of as low as 50 tons per day and can be established at a capital cost of $33 million at 1976 prices. Contrary to conventional wisdom, the pulp and paper industry appears to be flexible in its choice of scale of operation.

The concept of the small- to medium-sized integrated pulp and paper mills opens up a number of potential investment opportunities which have not hitherto been considered, because of the blinkered concentration on market pulp mills which require massive capital investment, major resource commitments, and sophisticated servicing. The smaller mills employ more people per unit of investment. They are not subject to the vagaries of external demand. They reduce the dependence on outside, foreign technology. This is noteworthy for two main reasons: operating costs are lower because foreign experts are expensive; and, more important, the spirit of self-reliance, so vital for the self-respect and spiritual development of the developing countries, is more easily fostered. They demand less capital, thus bringing the investment possibly within the reach of the developing countries themselves, but certainly within the grasp of the regional banks.

Strategy

The strategy we intend to recommend to the developing countries is therefore as follows:

- Do not attempt to imitate the industrialized countries in their pursuit of producing the biggest and the most. Given the existing economic order, you simply cannot compete with the developed world in a game which they have been playing for a long time, and for which they have formulated the rules. In any case, it is doubtful whether the practices of the developed world in the field of pulp and paper are worth emulation.
- If there are tied, agreed and firm markets for the pulp that you are capable of producing, then other things being equal it could be good policy to produce pulp alone. Do not, except under the most exceptional circumstances, produce market pulp, that is, pulp which you hope to sell. In general, your economies cannot afford the risk of failure to sell.
- Establish integrated pulp and paper mills and concentrate on the home and regional markets.
- Go for small- and medium-sized mills and do not be mesmerized by the conventional wisdom of the northern hemisphere in this regard. Consider the economic development of the national economies, and not solely the financial returns to the particular firm, the particular enterprise.
- Do not try to reproduce the quality of paper which obtains in the northern hemisphere for your local markets. The quality is often unnecessarily high, too costly, and a luxury the developing countries cannot afford.

With these principles in mind, we in the Food and Agriculture Organization have prepared a preliminary estimate of the total capital investment needed to establish pulp and paper mills in a range of developing countries.

We have identified 27 opportunities for investment in seventeen countries. The unit costs range from a capital investment of $40 million to $525 million for a regional pulp and paper mill in southeast Asia where all the conditions appear favourable for a large-scale enterprise. The total investment cost, at 1976 prices, is $6 803 million, of which $2 780 million are scheduled to be spent in the period 1985 to 1995, and the remaining $4 023 million are scheduled to be invested before 1985. If two large regional mills are excluded, the average cost of the mills we propose to recommend to be established is $175 million; however, the investment required for four of the mills is below $50 million, for nine mills it is between $51 and $100 million, and for another six mills it is between $101 and $130 million.

I believe that our examination of the political economy of the pulp and paper industry has served to demonstrate the complexity of industrial growth and development in the industrialized countries of the world. I think that from our analysis, the conclusion is inescapable and unavoidable that the developing world should not slavishly follow that pattern of growth and structure of the industry which has evolved and which prevails in the industrialized countries. If the developing countries continue to be advised by " international experts " to adopt the practices and customs of the industrialized north in the field of pulp and paper, and if they continue to accept their advice, they will be forced to labour, like Sisyphus, without adequate reward for their onerous efforts. If, however, they look anew at the subject, if they understand the implications of analyses such as we have done today, if they realize that a reverence for size is a snare and a delusion, then, perhaps, some progress might be made in the subsector of pulp and paper, and indeed in the entire forestry and forest industries sector. ■

Research in tropical wood utilization

Robert L. Youngs

Use more, waste less

In the New World, low-altitude wet evergreen tropical forests cover some 5 million square kilometres, and any one forest may support hundreds of tree species. Timber volumes may range from 150 to 300 cubic metres per hectare. Industrial fellings, however, are highly selective, and the harvest is often only 3 to 10 percent of this volume.

Most of the production of a large integrated manufacturing complex in the Guiana region of South America draws on only five species; 90 percent of roundwood exports were recently in two species; 95 percent of sawnwood exports in three species; and all plywood production and trade in one. Yet, technical data on the properties of some 50 species are well known, and half of these are classified as readily available in quantity.

High species selectivity is not unique to the Americas, for 90 percent of West African log trade out of Nigeria has been in only six species. Harvest by skimming is even more obvious in the rich forests of southeast Asia. For example, about 3 900 tree species have been described in the Philippines, but less than 100 reach local markets, and export trade is dominated by only seven.

Traditionally, our woodworking industries have been based on the "difference approach." Forests everywhere have been surveyed and screened to find species that could perform best for specific end uses. Just now, there is a movement, not only toward the development of "whole-tree" utilization systems, but also toward species-tolerant processes and products. The array of species feeding into pulp mills is a long step from the spruce-fir-poplar limitations of just a few years ago. Plywood sheets are overlaid, embossed, grained, stained, and marketed with no identification other than a decorator's "green cascade" or "sunshine gold." Certainly, particle board and fibreboard panels do not have botanical tags. Further development of machine stress grading can result in wood components of any species and grade being assigned to optimum cross-sectional and longitudinal positions in structural elements for an efficient and certifiable performance. For the heterogeneous lowland humid tropical forests, a more intensive pursuit of non-taxonomic or non-specific systems could permit a more flexible harvest of the timber resource.

Mixed though the lowland humid tropical forests are, similarities may appear in composition and form between widely dispersed timber stands. L.R. Holdridge at the Tropical Science Center, San José, Costa Rica, has quantified the forest shape or physiognomy based on life zones defined by rainfall, temperature, and evapotranspiration. If it can be demonstrated that the total wood resource, as well as the forest form, reflects the environmental conditions of a life zone, then processes can be developed based on this particular wood mix, regardless of species composition. Results would be applicable to large forest tracts, wherever located, that have the same life zone classification.

Recent studies at the U.S. Forest Products Laboratory, Madison, Wisconsin, show that wood specific-gravity distribution patterns for tropical American species are indeed unique to

EXAMINING A HUMID TROPICAL FOREST
nature, more varied than trade

ROBERT L. YOUNGS is Director of the U.S. Forest Products Laboratory maintained in Madison, Wis., by the Forest Service, U.S. Department of Agriculture, in cooperation with the University of Wisconsin.

certain Holdridge life zones. Specific gravity was chosen for this first probe because it correlates well with such important wood characteristics as mechanical strength, shrinkage, gluability, screw-and-nail-holding properties, cutting forces required in machining, and paper-sheet formation.

In the low rainfall (1 000 to 2 000 mm) tropical dry-premontane moist life zones species distribution is fairly uniform in all density classes from less than 0.30 to over 0.69. Within the tropical moist-premontane wet life zones (2 000- to 4 000-mm rainfall range), a high proportion of the species are generating very heavy timbers. The abundant rainfall (4 000 to 8 000 mm) of the tropical wet-premontane rain life zones favours species in the moderate density class of 0.40 to 0.49. This research work establishes a significant base for sampling in developing non-species-related processes and can also suggest the most suitable locations for industrial complexes that depend on timber.

Any-tree harvest

Present timber-harvesting systems for primary species could be encouraged if they perpetuated these favoured trees. Most often they do not. An " any-tree " harvest can avoid many forest-management problems that are still not solvable. Certainly, the site would be well prepared for high-yield plantation cultures or manipulation of pioneer species; but insensitive processes could also be catastrophic if raw material harvests are not tightly controlled or restrained where environmental impacts would be intolerable.

The Forest Products Laboratory, under agreement with the U.S. Agency for International Development, started a three-year cooperative research project early in 1975. The project has two related research objectives aimed at full-scale production of forest products in the lesser developed areas of the tropics.

Objective No. 1: through research, development, and pilot plant testing, to develop a technical and economic processing system for making pulp, paper, and related products from naturally occurring mixtures of tropical hardwoods. Such systems would be subject to the test of full feasibility and appropriate technology. Residues not acceptable for any of the forest products will be used to meet the energy needs of the processing system.

Objective No. 2: to design and assemble the elements of a "pre-feasibility package" based on the results of objective No. 1 and applied to one or more of three lesser developed areas (Latin America, Africa, and southeast Asia); and to disseminate, publicize, and demonstrate the " package " to potential investors in conferences and seminars.

Benefits expected from successfully achieving an operating facility include (*a*) new jobs for both skilled and unskilled workers, (*b*) production of forest products useful in developing local markets and competitive in world markets, (*c*) stimulation of ancillary industries, and (*d*) sizable savings in foreign currency exchange.

The planned research involves run-of-the-woods mixtures that simulate those found in the different climatic and geographic areas of the tropical forests. This approach was selected so that the information developed could be applied to any forest area of the tropics where even limited data on wood characteristics are available or readily gathered.

The basic premise for the research is that wood density is the most critical factor in determining the quality of product obtainable from a raw material supply. The question then becomes one of coping with unfavourable wood densities. Other factors such as silica content, extractives, and colour have been associated with certain processing and product-quality problems.

A second premise is that the natural tropical hardwoods are similar and information gathered in southeast Asia can be applied with good judgement to Africa and Latin America.

Unwanted trees

Information from the literature, from travel and mill visits by our staff, and from visitors to the Forest Products Laboratory reinforces the underlying premises and shows a need for this project. Present users and plans in progress selectively continue to exclude goodly numbers of wood species growing in the natural tropical forests. Such wood species are deemed " undesirable " for either product-quality or processing-problem reasons. This practice limits the development of a good and wisely applied silvicultural plan, leaving behind a forest of unwanted trees.

Wide sampling

To face this problem, specified areas in three countries, representing three geographical areas, were selected for sampling of the wood resource. These were, in the order sampled, the Philippines (representing southeast Asia), Ghana (Africa), and Colombia (Latin America). The method of sampling for each location was essentially the same. From the literature, species with specified values for density, silica content, and extractives were designated as potential samples; thus the chosen density distribution mixtures could be simulated, low and high contents of silica and extractives would be available, and a range of colour from light to dark would be present. Some freedom of substitution was allowed where local conditions made it difficult to harvest a preferred species.

In the Philippines, 50 species were sampled, in Ghana, 22 and in Colombia, 18. The greater sampling in the Philippines was due to the scheduled broader range of effort for the first sample and the plan to use subsequent samples for spot verification of the first results.

The wood was airfreighted to the Forest Products Laboratory, where each species was debarked, sampled for wood analysis, chipped, and stored in a cold room for subsequent use. Three chip mixtures were made with the wood from each country. In one, the density distribution was uniform, in the second the higher densities were favoured, and in the third the median densities were dominant.

These mixtures were then the basis for exploratory tests in pulping, papermaking, and board production to establish procedures for pilot-scale runs on a variety of products — market pulp, newsprint, school paper, tissue, linerboard, corrugating medium, fibreboard, and particle board. They were also subjected to further treatment,

based on the premise that eliminating the ultra-high-density chip material would result in significant quality improvements in the products under test. Thus, the mixtures were subjected to fractionation on typical equipment for separation by specific gravity and on vibratory screens. The use of vibratory screens was based on the observation that our chipper produced smaller chips from the higher density woods.

The exploratory work showed that market-quality kraft pulps (bleached and unbleached) could be obtained from each of the three basic mixtures. There were, however, significant but probably unimportant differences in quality. It also appears that the wood from Ghana provided better quality pulp for all three mixes than was obtained from the Philippine wood. Data on Colombian woods are not complete. In general, the quality of tropical-hardwood bleached krafts would be equal to, but more likely superior to, present hardwood pulps produced in the United States and Scandinavia.

The three Philippine mixes appeared to pulp well by the neutral-sulphite semi-chemical process, but here the presence of the higher density woods definitely reduced the quality factors important to the production of corrugating medium. Thus far, we have not established whether cooking to lower yield or using higher alkali concentrations will permit the use of mixtures containing significant quantities of wood at densities above 0.66. With this question unresolved, neither the wood from Ghana nor Colombia has been evaluated by this process for possible use in corrugating medium.

Some efforts were directed at colour sorting of tropical hardwood chips by recognized optical procedures. While the system was reasonably successful, the rate at which chips could be separated was much too low to consider this as a commercial means to obtain light-coloured wood for the mechanical pulp required in newsprint. Thus, when newsprint is to be a manufactured forest product, log selection will be necessary to assure the light-coloured woods for the mechanical pulping process and thus avoid high bleaching costs.

Taking the chips from the three lightest-coloured woods, mechanical pulp was produced by the thermo-mechanical pulping process.

The resulting pulps were used in a variety of furnishes with tropical-hardwood bleached kraft and commercial sulphite or sulphate softwood pulps to make newsprint on our 12-inch-wide experimental paper machine. Test data would indicate that commercial quality, strength and printability can be produced with furnishes approaching 100 percent tropical hardwoods. In all likelihood, a furnish of all tropical hardwoods could be run with only occasional additions of softwood pulps to alleviate minor operating problems.

Cultural papers — school and writing — were feasible using a furnish of 80 percent tropical-hardwood bleached kraft and 20 percent of a long-fibred sulphite or kraft. The use of some thermo-mechanical tropical-hardwood pulp as a substitute for the tropical-hardwood kraft appears possible, should such a pulp type be available.

Tissue grades (facial and toilet) and towelling are also possible products where high percentages of tropical-hardwood krafts are usable. Characteristics similar to commercial grades were found for furnishes containing as much as 80 percent tropical-hardwood kraft.

Paperboard

The work on linerboard and corrugating medium is still in process because of problems in the corrugating medium area. When these are resolved, the boards will be combined and made into boxes for testing. We expect to be able to report favourably on the use of tropical hardwoods for producing these boards.

It was mentioned above that the chip mixtures were fractionated by specific gravity and screening procedures to eliminate some of the higher density wood. There procedures have had varying degrees of success, depending on the quantity of high-density wood in the mixture. Apparently, improvements in kraft pulp quality of 10 to 25 percent are possible. Thus, these procedures may be useful when it is necessary to improve competitive quality or to make a supergrade of hardwood kraft which could demand a higher price on the market. The reject material could be used as fuel for the process energy needed to produce pulp.

Wet- or dry-formed fibreboards made from the three tropical hardwood mixtures easily met the Voluntary Product Standards for regular hardboard. In addition, furniture corestock and exterior-siding applications are possible with the respective resin formulations for such uses. In all cases, the fibreboard had excellent surface properties.

Although it is not a subject of research, a critical analysis has been undertaken of the literature relating to the environment and silviculture under a system which calls for more intensive utilization of the tropical forests. All of this is directed at applying the best technology to maintain the tropical forest as a renewable resource. Areas for research will be recommended.

In summary, forest products of satisfactory quality can be produced while using at least substantial quantities of the mixed secondary species from the tropical forests. If super-quality products are to be manufactured, the higher density woods can be separated by chip fractionation on screens and specific gravity separators. Any wood not acceptable for those forest products can be used as process fuel or for such other uses as chemicals and food.

Upon the completion of this research, an international meeting will present and discuss the new information, as well as other recent developments toward solving the technical problems restricting the use of the tropical hardwood resource. This meeting, the International Conference on Improved Utilization of Tropical Woods, will be held in Madison, Wisconsin, 21-26 May 1978.

Technical sessions in the preliminary plans include discussion of the resource, environment and silviculture, infrastructures, production of pulp, making of various paper grades, production of fibreboard and particle board, and finally application of the new technology. The agenda of the meeting appeared in the "World of Forestry," *Unasylva*, No. 116. ■

A Faustian dilemma

Whole forests can now be utilized — and destroyed — by wood chipping machinery. Can such technology be controlled? Can economic and ethical considerations co-exist?

Dennis Richardson

The dilemma which Mephistopheles presented to Dr. Faustus was one which faces most of us at some time or other — a choice between possible future returns and immediate gain. Since future returns are necessarily hypothetical, the judgement of history upon Faustus has always seemed to me self-righteously harsh. It is a judgement, however, which history may yet come to make upon foresters. The purpose of this article is to sound a warning that, in our current preoccupation with total forest harvesting and whole tree utilization, we may attract (and more deservedly than the unfortunate hedonist) a similar judgement from posterity.

The past two decades have seen a dramatically increasing demand for reconstituted wood products (pulp and paper, fibreboards and particle boards) throughout the developed world.

These increasing demands have led to impressive developments in the production and transport of wood chips, and in the variety of raw materials accepted by the manufacturing industries. In Japan in 1950, no hardwood was used as pulpwood; by 1970 the hardwood to softwood ratio was 60: 40; the increase followed a logistic curve with a point of inflexion about 1960. More recently, wood chips have been replacing logs as the delivered raw material, the ratio of chips to logs reaching 75: 25 in 1971. These developments in Japan have been accompanied by massive imports of wood chips, initially from the west coast of North America (200 000 tons in 1965 rising to 4 million tons in 1970), New Zealand (exceeding 2 million tons in 1973), and Australia (1.4 million tons in 1971, over 3 million tons in 1973, with as much as 30 million tons projected for 1988). Wood chip harvesting operations have now begun in Brazil, Malaysia, Thailand, Indonesia, the Philippines and Papua New Guinea, with exports of rubber wood, mangrove and mixed tropical hardwood chips. Other tropical countries are planning similar developments.

The utilization of mixed tropical hardwood chips for reconstituted wood products has a particular significance. Traditionally, as we all know, high forest areas in tropical countries have been exploited for a very limited number of species; in many cases, less than one stem per 0.4 ha is harvested. Because timber harvesting opens up hitherto inaccessible areas, however, logging is often followed by burning of forest for agricultural settlement.

Thus, the harvesting of mixed tropical hardwood species for the manufacture of reconstituted wood products makes possible a massive increase in raw material utilization and provides profitable outlets for hitherto unused species (f.o.b. prices for mixed tropical hardwood chips from Papua New Guinea exceed US$25 per " bone dry unit," i.e., 1 090 kg, approximately equivalent to US$23 per metric ton). It is scarcely surprising that, after living with the problems of underutilized species for so long, foresters should contemplate the prospect of multispecific chip-wood harvesting with unmitigated pleasure.

It is not the desire of the author to play the role of the ancient mariner at this marriage between forester and logger, but our excitement must be tempered by awareness of some possible deleterious (even disastrous) consequences of uninhibited forest clearance in some tropical areas. Chipwood harvesting in the temperate zones, and rubber plantation clearance present few problems, since the objective of such programmes is to replace poor resources with higher yielding species and varieties. Similarly, where in tropical regions the objective of

DENNIS RICHARDSON, of J.G. Broome and Associates, forestry consultants, Taupo, New Zealand, was formerly Professor of Forestry at the University of Wales; before that appointment he was director of the New Zealand Forestry Service Research Institute.

land clearance is the establishment of food crops — and where site selection is based on objective ecological appraisal — there can be no reasonable opposition to chip harvesting. It is otherwise in the mangrove areas, and in rain forest where there is no land hunger. And yet it is precisely these latter areas which are now being sought out for chipping operations.

The reasons for the selection of the more remote areas are not hard to find; because they are unpopulated, or only sparsely settled, there are few problems of land tenure or traditional rights of usufruct to deter the legislators responsible for the allocation of concessions, or to interfere with the operations of the loggers. There are no environmentalist irritants or inconvenient demands for impact statements. And, because of an evident lack of local labour, there is relative freedom for the concessionnaire to import indentured expatriates. There are, of course, many difficulties in operating in such areas, but they are evidently outweighed by the advantages; in any case, they are outside the scope of this article.

What, now, are the hazards of omnispecific wood chip harvesting? They are primarily ecological and they stem from our ignorance, as foresters, of tropical forest ecology.

Mangroves have been selectively exploited on a small scale for generations — for building poles, fuelwood, charcoal, tanning extracts (cutch), etc. Most species regenerate readily under these conditions, and with a minimum of intervention from the forester; where they do not do so, they can be planted.

A chip harvesting operation, however, is not selective, even though lip service may be paid to the concept of selective cutting; moreover, its scale may be such that the cleared areas are well beyond the biological capacity of the species for natural regeneration, and the resource capacity of forest services for replanting. The effects of chemical defoliants in Viet Nam are now sufficiently well documented to demonstrate the limited regenerative potential of mangroves; and there are few foresters who can lay claim to sufficient financial and manpower resources to be able to undertake replanting to the extent required by chip harvesting projects. Most importantly, our understanding of the effects of mangrove clearance on such features as coastal erosion, the mobility of sand bars, tidal and current movements, fish breeding, etc. — as well as the more immediately disruptive effects (albeit on a smaller scale) on villagers whose lives and livelihood may partly depend on the mangroves — is frighteningly deficient. We can (and do) prescribe the retention of narrow coastal strips and cutting to girth limits, but even when such prescriptions can be effectively policed (an impossible task in some areas), they are at best hopeful palliatives deriving from experience wholly inappropriate to modern chip harvesting practices.

The rain forest is no cornucopia; much of it is of low fertility, adapted to survival by an almost leak-free nutrient system and rapid recycling.

The need for practical field investigations of these problems, and for the close monitoring of cutting effects, is urgent and obvious. The need for more extensive and immediate research ought to be stressed by forest services and any other agencies which advise on forestry. The adoption of resolutions in the comfort of conference halls and administrative offices, however, is a universe away from their implementation in the swamps of the mangrove habitats.

The case for caution in our approach to mangrove clearance is a relatively easy one to argue. It is less simple in the case of the rain forest, in view of its vastness, its richness in terms of species, and the apparently unlimited fertility indicated by its luxurious vegetation. Yet these features are all of them illusory.

Firstly, the seemingly unlimited extent of the rain forest is more than matched by the speed of its disappearance. What once stretched virtually unbroken over all the lowlands of the humid tropics and remained more or less intact for over 60 million years has, in the last 200 years, become fragmented and is being reduced at a rate greatly in excess of that of earlier forest removal in the temperate zones of America, Europe and Asia. Through clearance for plantation crops and shifting agriculture, the pace of destruction over the last 20 years has been such that if it continues the world's rain forests (and much of the flora and fauna they support) will, except for a few poor relics, vanish within the next half century.

Similarly, the species richness of the rain forest is but a fraction of what it once was; because lines of communication have been cut by fragmentation, the rain forest can no longer play its traditional role as the gallery and issuing house of genetic and evolutionary diversity. Some biologists (informed scientists — not case-hardened "econuts") would go so far as to assert that through rain forest destruction man has permanently diverted the course of evolution.

Finally, and most important, the alleged luxuriance of the rain forest vegetation is a myth, deriving no doubt from the large size of the trees, the storeyed structure of much of the forest, and the impenetrable appearance of its edges when viewed from rivers, roads and airstrips. In from the edges, however, the ground flora is often sparse and, even in clearings, vegetation growth rates are extremely low. The rain forest is no teeming cornucopia; much of it, in fact, is of low fertility adapted to survival by its almost leak-free nutrient system and rapid recycling.

In an undisturbed state, losses from the system are made good not by the weathering of the parent rocks (which occurs well below the level of the characteristically shallow root systems of the trees) but by additions in rainfall. (There are, of course, exceptions to this generalization — for instance, in areas enriched by alluvium and vol-

canic ash; but there are also large podzolic areas, such as the Kerengas of Kalimantan, which support high forest but which, on clearing, cannot sustain even one harvest of rice. There are laterites, too, which bake hard on exposure and can then support no vegetation; and there are abundant steep sites which when cleared will simply erode to barrenness.)

The fact that the most successful agricultural crops grown in rain forest areas are those from which only small quantities of nutrients are removed in harvesting (e.g., rubber, cocoa, oil palm, etc.) is not without significance.

A crude index of rain forest fertility in some areas subject to shifting cultivation is the number of annual harvests which are taken before a new " garden " has to be sought. For most of the rain forest, three to four such harvests represent an unusually high number; in some sparsely populated areas — where wood chip operations are being established — a single harvest is the norm. (There may be, in fact, a causal relationship between poor soil fertility and low population densities. Shifting cultivators are not as unintelligent as we sometimes imagine; at least one tribe in Irian Jaya [West Irian], for example, uses a highly sophisticated site classification based on the use of indicator tree species — an accomplishment not yet matched by our scientifically trained agricultural botanists or foresters. And it is a not unreasonable hypothesis that areas in which no one claims rights of usufruct exist simply because such rights are worthless due to infertile soils.) In any event, the location of wood chip ventures in rain forest areas gives cause for concern because — as in the case of the mangroves — foresters are woefully ignorant of the possible after-effects; the credibility of our claim to ecological expertise is already sufficiently stretched for us to be extremely wary of its further extension.

It will, of course, be argued that wood chip harvesting agreements invariably incorporate provision for reforestation. (The good intentions of such provisions are not in question; but, as everyone since Samuel Johnson is aware, " the road to hell is paved with good intentions.") Assuming that planting takes place, reforestation will be with fast-growing species, usually exotics. How confident can we be, one wonders, of the capacity of the sites to sustain high growth rates beyond the first short rotation? If they can, the position will be similar to that in non-tropical areas where an unproductive resource has been replaced by a more useful one, and, in the author's view, there can be be no argument about its desirability. But with our present knowledge of the fragility of the rain forest ecosystem and our lack of knowledge of fertility distribution within chip harvesting concessions, ultracautiousness surely represents a wiser policy than the Faustian alternative.

What is most troubling is the operational scale of chip-wood ventures. The problem is analagous to that of supertankers (and the new dimension assumed by problems of oil spillage) or nuclear fission technology — and it cannot be answered by our new panacea, cost-benefit analysis, however sophisticated. Like the choice which faced Faustus, our problem is essentially ethical, not economic. Are we justified in developing a technology which may prove dangerous and uncontrollable?

Are we justified in developing a technology which may prove dangerous and uncontrollable?

In urging caution in approaches to multispecific wood chip harvesting in the tropics it is not enough merely to annotate possible hazards. Positive resolutions, even if controversial, are needed. Here are four to present to any forest service or agency dealing with this form of harvesting:

1. That immediate steps be taken in the countries concerned and by the international agencies to monitor the oceanographic, riverine and biological effects of current wood chip operations in mangrove areas; and that, until such effects are more clearly known, large-scale harvesting of mangroves be resisted.

2. That countries engaged in — or contemplating — omnispecific wood chip harvesting in tropical rain forest ensure that comprehensive site evaluations precede the granting of forest clearance concessions; and that such concessions be limited to areas where continuity of a productive cover can, as far as is humanly possible, be guaranteed.

3. That in granting wood chip harvesting concessions, the legitimate interests of peoples whose lives or livelihood may depend upon the continued existence of a vegetative cover be fully protected.

4. That foresters in tropical countries endeavour to limit wood chip harvesting concessions to ongoing logging operations on lands that they suspect will be subsequently converted to non-forest uses — whether by accident or design.

If the last of the foregoing resolutions could be successfully implemented on a world-wide basis, and logging residues from existing operations fully utilized, the first three would be unnecessary; there would be sufficient wood chips available (together with those from temperate zones, rubber tree replacement areas, etc.) to satisfy world demand now and in the foreseeable future. And all those so-called secondary species which concern us so much would be fully utilized. It is a chastening fact that the annual growth of extant forest plantations (based on data presented at the World Consultation on Man-made Forests — which are, admittedly, of doubtful accuracy) amounts to nearly 40 percent of annual world wood consumption. These is, thus, no impending world shortage of wood; but there is a very real danger of a world shortage of natural forests.

To return briefly to the introduction, despite the hypothetical future rejected by Faustus, his torments (as portrayed by the poets, dramatists and composers) were, when the day of reckoning arrived, real enough. The choice for foresters, surely, is not such a difficult one. ■

Timber standards based on end use

for more efficient utilization of forest resources, especially in the tropics

J.D. Brazier and C. Webster

Widespread use of tropical hardwood developed in most industrialized countries in the post-Second World War period and since that time has steadily increased. Thus, in the past decade, exports of tropical hardwood have multiplied threefold, with by far the greatest volume increase coming from the southeast Asian countries. Today, three territories, Malaysia, Indonesia and the Philippine Islands, produce almost 80 percent of the world's tropical hardwood exports and together have increased their export volume of roundwood from 6.6×10^6 to 29.5×10^6 m^3 in the last decade. Hardwood, and especially tropical hardwood, cut for industrial use represents only a small proportion (27 percent) of the total hardwood felled, with by far the greatest volume being used for fuel. However, the industrial cut is a highly selective one, dominated in many countries by a few well-known and commercially accepted timbers. Thus, the extent to which the forest is worked over is out of all proportion to the volume of timber removed for industrial use; this, in itself, might not matter, but commercial extraction, even on a highly selective basis, often makes the forest accessible to the farmer or crop planter and leads to its further degradation or destruction.

Concern has been expressed, and rightly so, on two main counts. First, that the rate of forest loss must be slowed and, second, that the policy of highly selective species exploitation must be modified, if both long-term botanical and commercial interests are to be respected. How can this be done? One answer is to utilize a far greater proportion of the forest which means a much greater number of species of timber. This is an answer which has been given on numerous occasions and over many years, but with a few noteworthy exceptions has yet to be realized. Why?

Clearly, there is a complex of practical considerations which have contributed to the situation, but there is an underlying philosophical aspect which is believed to be important and which perhaps has not received the consideration and discussion it warrants. Timber selection for use is species oriented, sometimes on the basis of traditional use, but more frequently on considerations of availability, cost, size and performance. The relative importance of these four factors is arguable but performance or, more strictly, an appropriate combination of technical properties is often among the last to be considered.

When a timber is no longer used, usually because of cost or difficulties of supply, another is sought often on the basis of comparability with that formerly used and most frequently from among those already commercially known. This is commonly a matter of expediency but even when promotion of a timber is extended over a period of time, its acceptance is far from certain and the costs involved are often considerable. This stems from the need to integrate the unknown with the current species in use, where it must be shown to perform at least as well and perhaps even more favourably and at an acceptable — which usually means lower — cost compared with the preferred timbers. This is a difficult task in the face of a determination by many users to persist with the known rather than risk the unknown.

A further contribution to an emphasis on species selection has been the form in which much timber information has been presented. Handbooks giving information on world or

J.D. Brazier and C. Webster are with the United Kingdom's Princes Risborough Building Research Establishment.

national timbers invariably follow a species classification. The publication of such handbooks detailing the results of systematic testing of physical and technical properties has undoubtedly contributed to the more efficient and economic use of many timbers, but it has contributed also to the perpetuation of a system where species is compared with species and substitution sought in terms of comparability between species. It is this emphasis on species description and selection for use — and many major user countries have produced such information — which has favoured the known compared with the less familiar and obscured the need to provide guidance on property needs appropriate to end use.

Information

In complete contrast to the volume of information about timber species is the very limited information available on the property requirements for end use, and yet this must be the only sound technical basis for timber selection. Currently we are, at Princes Risborough Building Research Establishment, attempting to remedy this need so far as the United Kingdom is concerned and, in so doing, provide a guide on species selection for the benefit of all concerned with timber, whether producers, specifiers, processors, or users.

An end-use property classification defines for each type of timber product the properties of significance and their levels such that timbers meeting these property requirements can be expected to give a satisfactory performance both in manufacture and use. The properties selected and levels proposed are a matter of judgement, based on experience of the factors affecting performance, and guided by specifications or standards where these exist for an end product.

In developing the Princes Risborough classification, emphasis has been directed in the first place mainly to timber products used in building and, at the time of writing, property requirements have been defined for various types or parts of window joinery, door frames and doors, cladding, flooring and cabinet work. As an example of the classification and its format, the section dealing with windows is reproduced in Table 1.

Using the information on property requirements for a product it becomes possible to identify, from among the timbers for which detailed technical information is available, those which have the appropriate properties to the required level and can be expected to be suitable for the product. As part of the current study a sorting system, using edge perforated cards, has been developed to select timbers with required combinations of properties. It is used to select timbers appropriate to a purpose and these are listed for each of the products for which property requirements are defined; only a selection of the timbers currently available in the United Kingdom and suitable for window joinery is given in Table 2. Any such list can be added to as new timbers come on offer, always provided that adequate technical information is available to enable the selection procedure to be followed; alternatively such a property classification highlights properties for which information is needed if a timber is to be considered for a particular purpose. The end-use property classification provides the means, for the first time, for the timber producer, specifier or user to make an objective assessment of the fitness or otherwise of a timber for a particular purpose.

In a consideration of Table 1, there are a number of points which warrant comment. The properties for which levels are quoted are those usually assessed in a physical and technical appraisal of timber; the descriptive terms used for levels of performance, in most instances, correspond to those adopted in the British literature, notably the handbooks and other publications issued from the Princes Risborough Laboratory. The properties of significance and the levels within them are summarized briefly as a note to Table 1.

Performance

A second and very important point concerns the levels of performance quoted. As the classification system developed, it became evident that it is both unrealistic and unhelpful to base the requirements for each property on a single performance level, thereby creating, in effect, a single performance specification. Clearly there is a need for a specifier or manufacturer to have a freedom of choice, bearing in mind the conditions and duration of use for a product and the facilities available for its manufacture. Thus, qualification is needed in two ways. In the first, the preferred level of performance is obtained but only with some additional processing requirements; thus acceptability depends on the combined cost of the selected timber and additional processing compared with the cost of a timber where the additional processing is not required.

Choices

In selecting for windows, an example is the choice between a timber rated moderately durable or better for which preservative treatment is not necessary and one of lower durability and requiring treatment; another example is between a timber which does not rapidly blunt high-speed cutters and one which is abrasive and for which tipped cutters are needed. In these examples if the cost of preservative treatment or of using tipped cutters can be justified in relation to other costs, then a more perishable timber in the one case and a more abrasive timber in the other can be accepted. In these examples there is no lowering of performance in use but in other instances a less exacting standard can be accepted and this is the basis for the second qualification to the proposed levels of performance. To meet this option, the " preferable level " for a property is varied to give an " acceptable level " which, though lower, is nevertheless considered to give an adequate performance for many conditions of use.

In adopting such a system, the listing of a timber for a particular purpose must indicate for each property whether it is met at the preferable level, at the preferable level after some modification in processing, or at the acceptable level. An example is given in Table 2

where timbers are listed which are suitable for windows. Each reaches the preferable level for all properties except those indicated by a code number; for these the preferred level is met with modified processing if the number is in brackets and the remaining numbers indicate properties reaching an acceptable level.

Properties of significance and property levels are quoted with respect to the conditions prevailing in the United Kingdom. Clearly considerable differences can be expected in preferable levels, especially for properties affecting performance, for a product used in a tropical as distinct from a temperate environment, and some difference could well occur in requirements for such properties between use in the maritime U.K. and parts of continental Europe. It is a matter of some interest, therefore, to examine on an international basis the effect of differing national standards or requirements with respect to performance and processing on property needs and levels. For this purpose an agreed terminology for defining levels within a property becomes essential.

Further, it should be stressed that the system, by defining property levels, provides a means of selecting species for a particular purpose. On occasions it has been described as end-use grading but end-use classification is a preferred descriptive term as it in no way replaces or dispenses with the need for conventional grading requirements. The two procedures, end-use classification and timber quality grading, combine for end-use marketing, when, it is to be expected, quality grading will be such as to meet the special needs of the end product.

How, it might be asked, does such a development lead to the more efficient

AT AN INDONESIAN SAWMILL
putting the end first makes sense economically

PROPERTY CLASSIFICATION FOR WINDOW FRAMES, SILLS, CASEMENTS AND SASHES

TABLE 1
(Property requirements and levels)

Property of timber	Preferable levels	Acceptable modifications
1 Natural durability (*i*)	Moderately to very durable or perishable or non-durable treated according to Preservation table (*ii*)	—
2 Density	Softwoods averaging not less than 450 kg/m³ Hardwoods averaging not less than 530 kg/m³	Softwoods averaging 370 kg/m³ (*iii*) Hardwoods averaging 450 kg/m³ (*iii*)
3 Dimensional movement	Small	Medium
4 Grain	Typically straight or shallowly interlocked of which the general direction is straight	Typically interlocked of which the general direction is straight
5 Drying rate	Rapid to moderate	Fairly slow to very slow (*iv*)
6 Tendency to checking during drying	Absent or controllable	—
7 Tendency to distortion during drying	Absent or slight	Moderate (*v*)
8 Blunting effect on cutters	Slight to moderate or severe if tipped cutters in use	—
9 Machining	Satisfactory or satisfactory with modified cutting angle	—
10 Tendency to resion exudation	Absent or infrequent after drying	See Note (*vi*)
11 Tendency to corrode metals	Absent or present only if adequately protected fixings are used	—
12 Staining in contact with metals	Absent or present if avoidable	Present if visually acceptable
13 Staining of adjoining materials by leaching of colour	Absent	Present only if not objectionable in particular situation
14 Texture	Fine to medium	Coarse (*vii*)

(*i*) Classifications refer to durability of heartwood and *exclude all sapwood.*

(*ii*) Preservation Table.
This table provides general guidance on suitable methods of preservation for timbers of low durability to improve their service performance to the required level.

Natural durability	Treatability			
	Permeable	Moderately resistant	Resistant	Extremely resistant
Perishable or non-durable	Immersion (softwood only) Double vacuum Pressure impregnation	Double vacuum Pressure impregnation	Double vacuum Pressure impregnation	Not acceptable

Alternatively to what is indicated in the above Table, any species of timber pre-treated by the boron diffusion process gains in durability.

(*iii*) Timber of average density below "Preferable levels", especially tropical hardwoods of wide density range and softwoods below 420 kg/m³, should be used only with careful attention to screw-thread length and automatic screw driving techniques; it is not recommended where frequent careless usage may occur.

(*iv*) Not included in "Preferable levels" because of risk in commercial practice of uneven drying through thick cross-sections; with strict application of correct drying techniques, performance will equal that of more rapid drying timbers.

(*v*) In conjunction only with "Small movement" classification.

(*vi*) Acceptability depends on finish to be used and visual standards required.

(*vii*) For exterior use, timbers with very coarse texture are the least satisfactory for painting and varnishing; an exterior wood stain is the most appropriate treatment.

Concerning the properties *

1. DURABILITY. Based on the life of heartwood when in contact with the ground in temperate climates and classified in the following five grades. *Very durable* (more than 25 years); *durable* (15-25 years); *moderately durable* (10-15 years); *non-durable* (5-10 years) and *perishable* (less than 5 years). All sapwood is classed as *perishable*.

2. DENSITY. At a moisture content of 12 percent.

3. DIMENSIONAL MOVEMENT. Classified as *small*, *medium* or *large*.

4. GRAIN. Classified descriptively as *typically straight* or *interlocked*, etc.

5. DRYING. Drying rate is classified as *rapid*, *fairly rapid*, *moderate*, *rather slow*, *slow*, or *very slow*.

6. TENDENCY TO CHECKING DURING DRYING. Classified as *absent*, or *controllable* or *present*.

7. TENDENCY TO DISTORTION DURING DRYING. Classified as *absent*, *slight*, *moderate* or *severe*.

8. BLUNTING EFFECT ON CUTTERS. Classified as *slight*, *moderate* or *severe*.

9. MACHINING. Includes sawing, planing and other cutting operations and classified as *satisfactory* if an acceptable surface for the utilization can be obtained.

10. TENDENCY TO RESIN EXUDATION. Classified as *absent*, *infrequent* or *present*.

11. TENDENCY TO CORRODE METALS. Classified as *absent* or *present*.

12. STAINING IN CONTACT WITH METALS. Classified as *absent* or *present*.

13. STAINING OF ADJOINING MATERIALS. Classified as *absent* or *present*.

14. TEXTURE. Classified as *fine*, *medium* or *coarse*.

* For a more complete treatment of these properties, see the introduction to *Handbook of Hardwoods 2nd ed.* (Her Majesty's Stationery Office, London 1972) and the *Handbook of Softwoods* (Her Majesty's Stationery Office, London 1957).

use of the world's timber resource? The answer is by its contribution to the development of a system of marketing timber for end use rather than by a commercial name. It has been emphasized that an end-use classification recognizes timbers appropriate to particular end uses and when combined with specifications concerned with timber quality and size, the technical requirements for end-use marketing are met. With end-use marketing a consignment may comprise a single species, and indeed would need to where appearance is a matter of importance. But for many timber species appearance is of little significance and mixed species, provided that they meet certain common requirements with respect to performance and processing, could then be marketed together. It is the prospect for marketing mixed species which offers scope for the more effective use of the tropical forest resource.

A common problem in the marketing of many tropical timbers is their sporadic occurrence necessitating a sorting and collecting procedure if an adequate consignment is to be obtained, and even then unless a regular supply is forthcoming promotional activities can come to nothing. Too often in the past technically promising timbers failed to become established because adequate supplies could not be maintained. Now, with the introduction of end-use marketing, such timbers can be grouped with others that have the same combination of properties and the deterrent to their being cut and the problems in making available regular supplies are much reduced. But there is a further advantage in end-use marketing in that for many purposes botanical identity could cease to matter to the timber specifier or user; propaganda or promotional activities by the timber supplier to establish a "new name" — often a frustrating procedure — no longer arises in the knowledge that timber shipped for a purpose is appropriate to that use. The concept of mixed species used for an end purpose is not such a novel idea as it might appear at first sight and a number of examples of its application can be cited: for example, marine ply to British Standard 1088 is made from a range of species meeting a required natural durability level, and much general purpose plywood from Malaysia and some from west Africa is marketed according to face colour (red or white) and not species, with commonly different and often a wide range of species in the core. Mixed west African redwoods have been used for parquet flooring, and mixed hardwoods, often of Malaysian origin, for such purposes as upholstered parts of furniture. Current ideas on the use of both softwoods and hardwoods for structural purposes are directed toward the development of strength groups and marketing to performance levels.

TABLE 2. — Timbers suitable for window joinery

The following timbers available in the United Kingdom are among those suitable for window frames, sills, casements and sashes. No timber meets the preferable level with respect to every property given in Table 1. Those where attention is required are indicated by numbers corresponding to the property list. Numbers in parentheses indicate a process modification to reach a preferable level and numbers not in parentheses indicate acceptable modifications as given in Table 1.

Afrormosia (*Pericopsis elata*) 4, 5, (9), 12

Afzelia (*Afzelia* spp.) 4, 5, (9), 13, 14

Agba (*Gossweilerodendron balsamiferum*) 4, (9)

Ayan (*Distemonanthus benthamianus*) 4, (8), (9), 13

Western red cedar (*Thuja plicata*) 2, (11)

Douglas fir (*Pseudotsuga menziesii*) 10

Idigbo (*Terminalia ivorensis*) (9), (11), 12, 13

Iroko (*Chlorophora excelsa*) 4, (9), 14

European larch (*Larix decidua*) 7

African mahogany (*Khaya* spp.) 4, (9)

American mahogany (*Swietenia macrophylla*) 4

Dark red meranti (*Shorea spp.*) 4, 5, 7, (9), 14

Redwood (*Pinus sylvestris*) (1), 3, 10

Sequoia (*Sequoia sempervirens*) 2

Teak (*Tectona grandis*) 5, (8) (9), 14

Utile (*Entandrophragma utile*) 4, (9)

Whitewood (*Picea abies*) (1), 3.

It is emphasized that classification and marketing for end use make the need for reliable technical information on a species more rather than less important, unless it is to be used for a non-demanding purpose. This is because the sawmiller, or other processor, must ensure that the timbers he markets for a particular purpose have the required technical properties. This point is made because in many and probably most of the tropical hardwood forest areas much remains to be determined concerning the properties of the so far little-used or unused species and this is a first priority for more efficient exploitation and the introduction of end-use classification and marketing.

Finally, the concept of end-use marketing has to be seen in the light of likely developments in timber production and supplies. Marketing for end use and a shift in responsibility for timber selection to the primary processor are in accord with the likely development and demands for increased processing in the countries of timber production. As this develops, so clearly does the need for a greater awareness of the end uses to which the timber is to be put and the property requirements for these end uses. And, although it may take some time, sooner or later wooden components, manufactured for overseas markets and to performance levels demanded by those markets, will be produced. It is not, after all, such a far cry from blockboard to flush doors and if flush doors why not other joinery, windows, etc. and parts of furniture?

Such changes in commerical practice are some way off and, in the meantime, there is an increasing awareness that current practices with respect to the production and supply of timbers must be moderated if the forest is not to be destroyed at an unacceptable rate, especially in those regions of the world supplying a large part of the international trade in tropical hardwood. There is no simple or single way to reduce the rate of destruction of the forest, but it is suggested that the proposals made here represent a contribution to its more effective use.

Firstly, defining property needs for different end uses contributes to a more effective selection and to economy of timber in use, and secondly, by developing end-use marketing, species currently unused or under-used, instead of being left in the forest and thereafter commonly destroyed, might be brought into use and so reduce rates of forest exploitation and loss. ■

Educating for forest industries in the Philippines

Domingo M. Lantican

The Philippines has a total land area of 30 million hectares, out of which 57 percent — 17 million hectares — is classified as forest land. Commercial forest has an area of 7.37 million hectares; non-commercial forest of 4.72 million hectares can be developed and brought back to production. National policy calls for a permanent forest area of 40 percent (12 million hectares); forestry is therefore expected to continue to be a main source of revenue for the country.

The annual cut is about 14 million cubic metres, which places the Philippines 15th in rank among the world's timber producers and the fifth in plywood production.

Composition of the stand is mixed tropical hardwood with Dipterocarps as the predominating species. Softwood species are limited to higher elevations and occupy a total area of approximately only 200 000 hectares. At present less than a hundred or so species are considered commercial, but these compose the main bulk of the commercial stand, estimated at 1.6 thousand million cubic metres.

Besides export earnings, the industry provides employment to over 350 000 people directly and close to 2 million people are dependent on it for their livelihood. But in spite of its importance, the country's economists continue to criticize the export of forest products because of the predominance of raw timber over finished products in the international trade. For a country in which unemployment is a vexing problem, such a situation cannot escape the attention of national planners; therefore the phasing out of timber export has been adopted as a national policy. However, the total ban scheduled for January 1976 has not been fully implemented.

The restriction on the exportation of logs is designed to stimulate the processing of wood products in the country in the hope that it will bring in more foreign exchange and also provide more employment opportunities. At present there are over 400 wood-processing plants in the country. These include 355 sawmills with a total capacity of about 7 million board feet daily; 18 veneer mills; 31 plywood mills; 22 pulp and paper mills; 2 fibreboard plants and 13 blockboard plants. In addition there are several furniture factories which utilize wood as raw material.

An ambitious plan for expanding existing plants and building new mills has been approved by the Government. This means that the number of people now employed by the wood-using industry must increase correspondingly. Within three years from the time the log embargo is implemented, over 20 thousand additional workers will be needed by the forest industry. Since most of these people must be in the skilled category, it is important that an intensive training programme be conducted by the country.

The professional foresters employed by the industry may be grouped into those who are employed in the field or forest (e.g., in silviculture, forest management, forest inventory and logging) and those employed in the mill (sawmilling, wood machining, seasoning, preservation, plywood manufacture and pulp and paper making). At present there are more people employed in the forest than in the mill because the supply of the latter category is quite low and the major output of the industry is logs rather than processed products.

Professional training in forestry is available in most of the 15 or so schools of forestry in the country.

Best equipped is the College of Forestry of the University of the Philippines at Los Baños, established in 1910. Training is offered in the fields of forest biological sciences, forest resources management, forestry extension and wood science and technology.

DOMINGO M. LANTICAN is Professor of Wood Technology, College of Forestry, University of the Philippines at Los Baños.

Two aspects of forest production are emphasized at the professional level: (*i*) the silviculture, management and protection of the natural forest; and (*ii*) the establishment and management of forest plantations. The former assumes importance in that almost all forest lands in the Philippines are government owned and its utilization must conform with the national policy of sustained yield management through selective logging. The latter is now gaining importance especially with the growth of the pulp and paper industry which gives assurance of a ready market for plantation-grown trees. Training in these areas is available at both the undergraduate and the graduate level.

The undergraduate programme covers a period of four years, with six weeks of practice in the field. It is a general course in forest resources management which includes silviculture, forest management, forest economics, forest protection, administration, and logging and transport. In addition, there is provision for elective subjects in various specialized fields. The coverage of the typical curriculum is broken down into 69 credit units of general education and other basic courses, 17 of forest biological sciences, 37 of forest resources management, 12 of wood science and technology, 12 of electives and 6 weeks of practicum, making a total of 153 units of credit. A credit unit may mean a one-hour lecture a week or a three-hour laboratory class a week. A subject consisting of 3 one-hour lectures a week is given 3 units of credit. A subject with 2 one-hour lectures and one 3-hour laboratory class a week likewise is given 3 units of credit. (See Table 1 for the Bachelor of Science in Forestry curriculum.)

Field work is emphasized which may range from 6 to 9 hours a week on the average for most technical subjects.

Training in wood science and technology leads to the degree of Bachelor of Science in Forest Products Engineering. Graduate degrees in the Master's or Ph.D levels are also available.

Graduates of the BSFPE curriculum are expected to know wood identification, the physical and mechanical properties of wood and the various aspects of wood processing such as sawmilling, wood machining, wood seasoning and preservation, plywood manufacture and wood lamination, wood finishing and pulp and paper technology. The course extends over a period of four years and two six-week summer sessions, one of which is devoted to experience in the industry. The course is composed of the following: 82 units of credits of general education and basic sciences, 21 of engineering science, 31 of wood science and technology, 15 of electives and 6 of practicum. (The course analysis is shown in Table 2.)

The technical subjects usually consist of 2 one-hour lectures and one 3-hour laboratory class a week.

The BSFPE programme in the Philippines is given by only one institution — the College of Forestry of the University of the Philippines at Los Baños which has a well-equipped Department of Wood Science and Technology. The students and faculty members of this College also have access to the facilities of the Forest Products Research and Industries Development Commission located on the same campus.

A PLYWOOD MILL
getting more attention in the university

Table 1. - **FOUR-YEAR BACHELOR OF SCIENCE DEGREE IN FORESTRY**
College of Forestry, University of the Philippines at Los Baños

Subjects	Credit units
General education and basic courses	
English literature, speech, scientific writing	15
Humanities, Philippine institutions	6
Social sciences	12
Biology	6
Chemistry	5
Physics	3
Mathematics including analytical geometry and calculus	9
Spanish	12
Technical drawing	1
	69
Forest biological sciences	
Morphology	5
Tree physiology and ecology	6
Entomology, pathology	6
	17
Forest resources management	
Forest biometry, statistics	6
Forest engineering	3
Timber harvesting	3
Timber management	3
Geology and forest soils	3
Silviculture	5
Forest policy and administration	3
Forestry economics	3
Forestry business management	3
Multiple-use forestry	2
Communication process (forestry extension)	3
	37
Wood science and technology	
Wood structure and identification	3
Wood physics and mechanics	3
Forest products utilization	6
	12
Field experience	5
Electives	12
TOTAL	**152**

At present, training of technicians for the forest industry in the Philippines is limited. The forestry schools provide a 2-year Ranger course, the graduates of which are employed by the industry in the nurseries and plantations and to help the professional foresters in log and lumber scaling and in forest inventory work. (There used to be a private school for Forest Workers several years ago.) For the workers in the mill, training opportunities are available at the Forest Products Research and Industries Development Commission. The University of the Philippines at Los Baños is contemplating a sub-professional 2-year forest products technology curriculum.

In the past, with the exception of the Ranger course, most of the skilled labour in the industry developed through in-service training which has worked quite satisfactorily. However, there is no pool of trained men available for new plants and this has resulted in "pirating" of skilled workers in existing plants. A massive expansion of the industry as envisioned by the country will require a constant supply of trained men.

The Forest Products Research and Industries Development Commission (FORPRIDECOM) has as one of its functions the training of manpower for the wood-based industries. It, therefore, conducts training courses in various aspects of wood processing: wood identification, dry kiln operation, wood preservation, sawmilling, log and lumber grading, veneer and plywood production, pulp and paper manufacture, particle and fibreboard manufacture, charcoal production, packaging and timber engineering design (see details in Table 3).

The training consists of lectures, laboratory work, field trips and plant visits. Syllabi, manuals, pamphlets, handouts and other training aids are

LIST OF USUAL ELECTIVE COURSES

1. Computer programming
2. Cytology
3. Experimental designs
4. Forest genetics and tree improvement
5. Forest parks and recreation management
6. Forest photointerpretation
7. Forest products entomology
8. Forest products pathology
9. Forest range management
10. Forest road engineering
11. Forestry extension methods
12. Log and lumber grading
13. Microbiology
14. Operations research
15. Planning and control of logging operations
16. Plant physiology

provided at nominal cost. Examinations, written, oral and practical, are given during the course work to assess the progress of the trainees, and certificates to those who satisfactorily finish the course.

The number of training sessions in a year depends on the industry's demand, the size of the facilities and the number of trainees. The length of the course ranges from 10 days to one month.

The training staff is composed of engineers, foresters, wood technologists, entomologists and other highly trained personnel. In addition, guest lecturers are drawn from the industry and other government agencies when necessary.

The training programme is conducted at the FORPRIDECOM. However, in-plant training is provided upon request. In such cases training teams for specific courses are sent to the company.

Most of the workers employed in the industry are either already skilled having come from another firm or are trained on the job by the more experienced worker. The system of apprenticeship is being encouraged by the Department of Labour as a matter of policy.

The College of Forestry of the Philippines at Los Baños is contemplating instituting a 2-year sub-professional course in forest products technology to train students for work in the wood-using industry. The course will be open to high-school graduates. The training will include wood identification, log and lumber grading, sawmilling, wood machining, knife grinding, lumber kiln operation, wood preservation, veneer and plywood manufacture, gluing, wood finishing and other aspects of wood processing. The course will differ from those at professional level in that they will be on the practical side with emphasis being given to the manipulative skills. The plan is to turn out at least 30 to 40 graduates every year for as long as there is a demand for such graduates.

Table 2. - **FOUR-YEAR BACHELOR OF SCIENCE DEGREE IN FOREST PRODUCTS ENGINEERING**

College of Forestry, University of the Philippines at Los Baños

Subjects	Credit units
General education and basic courses	
English literature, speech, etc.	15
General biology	6
Chemistry	10
Physics	6
Social sciences	12
Humanities, Philippine institutions	6
Mathematics	15
Spanish	12
	82
Wood sciences and technology	
Statistics	3
Economics of wood-using industries	3
Forest products	3
Wood structure and identification	3
Wood chemistry	3
Wood physics and timber mechanics	6
Identification of commercial trees	3
Introduction to forest resources management	3
Technical drawing	1
Research problems	2
Seminar	1
	31
Engineering science	
Statics, mechanics of rigid bodies in motion	6
Thermodynamics, heat transfer	6
Fluid mechanics	3
Electrical and electronics engineering	3
General surveying	3
	21
Electives	15
Practicum	6
TOTAL	**155**

17. Principles of industrial management
18. Production planning and control
19. Programme planning in forestry extension
20. Research problems
21. Sawmilling
22. Special studies in forestry
23. Timber management
24. Topics in mathematical forestry
25. Watershed management
26. Wildlife management
27. Wood anatomy
28. Wood chemistry
29. Wood lamination and adhesives
30. Wood machining
31. Wood preservation
32. Wood seasoning

The Department of Wood Science and Technology, University of the Philippines at Los Baños

The Department of Wood Science and Technology of the University of the Philippines at Los Baños was created in 1963 when the College of Forestry departmentalized the faculty at the same time that it offered major programmes in forest resources management, and wood products engineering.

Table 3. - **FOREST INDUSTRIES MANPOWER DEVELOPMENT PROGRAMME**

Offered by Forest Products Research and Industries Development Commission (FORPRIDECOM)

Course description	Duration	Admission requirement
1. *Wood Identification.* General properties of wood; identification of commercial species based on gross and microscopic features	1 month	High-school graduate
2. *Dry Kiln Operation.* Principles and techniques of wood seasoning; kiln operation and maintenance.	3 weeks	"
3. *Wood Packaging.* General properties of packaging materials; design and selection of packaging materials; performance test of packages and containers.	2 weeks	"
4. *Quality Control in Veneer and Plywood Manufacture.* Basic principles of quality control; raw material, process and product control; statistical quality control.	3 weeks	"
5. *Veneer and Plywood Technology.* Log preparation, veneer cutting, drying, glues and gluing, finishing, testing and evaluation.	4 days	"
6. *Lumber Grading.* Principles and practice of lumber grading.	3 weeks	"
7. *Log Scaling and Grading.* Methods of scaling, grading rules, field practice.	3 weeks	"
8. *Wood Bending and Lamination.* Preparation of materials and bending techniques.	10 days	"
9. *Wood Treatment Plant Operation.* Principles of wood preservation; enemies of wood, preservation techniques and economic aspects of wood seasoning.	3 weeks	"
10. *Sawmilling.* Sawmill machinery and accessories; sawmill layouts; production techniques, maintenance; mill residue utilization; marketing.	10 days	Key sawmill personnel
11. *Charcoal Production and Briquetting.*		
(a) Techniques of charcoal production and briquetting.	15 days	High-school graduate
(b) Processing and analysis; activated charcoal.	2 months	2nd year college
12. *Pulp and Paper Technology.* Raw material preparation, pulping techniques, paper making, pulp and paper testing.	2 months	B.S. Chem. B.S. Chem. Eng'g
13. *Fibre Studies and Pulp and Paper Analysis.* Structure of wood; characteristics of fibres; fibre identification and analysis, etc.	1 month	B.S. Degree Pref. B.S. Chem.
14. *Timber Engineering Design.* Strength properties of wood; stresses; beams and columns; joints; structural testing, etc.	4 weeks	B.S. Civil Eng'g B.S. Arch. B.S. Forestry
15. *Particle Board Manufacture.* Preparation of materials, manufacturing process and techniques, testing, etc.	1 month	B.S. Chem. B.S. Forestry
16. *Fibreboard Manufacture.* Pulping process, board manufacture, testing, etc.	3 weeks	B.S. Chem. B.S. Chem. Eng'g

The function of the department is to provide instruction and undertake research in wood anatomy and identification, the physical and mechanical properties of wood and timber structures, wood chemistry, sawmilling, wood machining, timber seasoning and preservation, wood lamination and plywood manufacture, pulp and paper technology, marketing and distribution and related fields. The department offers an undergraduate course leading to the degree of Bachelor of Science in Forest Products Engineering. It also services the Graduate School of the University by providing graduate courses for the Master's degree and Ph.D. programmes. The department is contemplating a sub-professional training course in forest products technology.

For the degree programmes the basic courses in mathematics, chemistry and physics, in addition to the humanities, social science and language courses, are given by the College of Sciences and Humanities. The engineering courses: Statics; Mechanics of Rigid Bodies in Motion; Thermodynamics; Fluid Mechanics; Fundamentals of Heat Transfer and Fundamentals of Electrical and Electronics Engineering are given by the College of Agricultural Engineering and Technology.

The facilities of the department include a Wood Science Building, sawmill and wood-processing laboratory. The laboratories are equipped for studies in wood anatomy, wood properties, wood machinery, wood seasoning, wood preservation. In addition to these, the facilities of the Forest Products Research and Industries Development Commission which is located on the same campus are available for student and faculty research projects.

There are at present 43 students enrolled in the B.S. Forest Products Engineering curriculum and 22 at the graduate level. The students are mostly from the Philippines, but some come from other countries in southeast Asia.

The faculty is composed of 12 members, six of whom hold Ph.D degrees, four with Master's degrees and two with Bachelor's degrees. Within the next two years it is expected that at least 9 members will be holding Ph.D. degrees and all the rest Master's. ■

When ambrosia beetles attack mahogany trees in Fiji

Hywel Roberts

Because of the absence from Fiji of the " shoot-borer " of Meliaceae *Hypsipyla robusta* Moore (Lep., Pyralidae) the Fiji Forestry Department, after trials, established plantations of " big-leaf mahogany " (*Swietenia macrophylla*) in the southeastern, high-rainfall area of the largest island of the group, Viti Levu. Trees were planted out after 1965 as base-rooted striplings at 11 × 3 m espacement in logged forest and managed on a 40-year rotation. By 1971, 8 294 ha had been established. The mahogany was grown to produce high-quality furniture timber and veneer. When the first detailed peeling trials were made in 1971 evidence of ambrosia beetle attack (shoot-hole borer) was found in the living tree. Infestation was high enough to suggest the problem was serious, and planting immediately stopped. A survey carried out in 1972 showed attack was present in all the main plantation areas (Naboutini, Ngaloa, Nukurua, Yarawa), but levels of infestation apparently varied widely within plantations (Mang and Vincent, 1972). Two non-selective ambrosia beetles, *Crossotarsus externe-dentatus* Fairmaire and *Platypus gerstaeckeri* Chapuis, both belonging to the family Platypodidae, were found to be responsible. The smaller species, *C. externe-dentatus*, is widely distributed in the tropics, being recorded in east Africa,

Shoot-hole borer attack in a mahogany log

also on islands

Hywel Roberts is with the Forestry Branch of Papua New Guinea. Under the auspices of the Ministry for Overseas Development, London, he spent six months (1973) in Fiji studying the ambrosia beetle problem.

most of tropical Asia, and east to Hawaii (Schedl, 1972). In contrast *P. gerstaeckeri* is endemic to Fiji. Within Fiji both species are common throughout the high-rainfall areas of the two main islands, Viti and Vanua Levu.

The attack

In the natural rain forest, both Platypodidae, as do most of this insect family, normally attack and breed within only newly felled, injured, or badly diseased trees. Where breeding is successful a gallery system, termed the nest, is made within the host tree, where the young are reared. During all developmental stages they feed on an ambrosia fungus that grows on the gallery walls, not on the wood. In felled trees the life cycle, from initial attack to emergence of young adults, in *C. externe-dentatus* takes about 50 days and in *P. gerstaeckeri* twice as long, about 100 days. The smaller species also differs from the larger in that the host is attacked within a short time — a few days or of felling, or injury. On felled trees attack by *P. gerstaeckeri* does not normally occur for some three to four weeks after felling. While both species are apparently non-selective with regard to plant families attacked (in Fiji *C. externe-dentatus* is recorded from 69 tree species belonging to 42 plant families, and *P. gerstaeckeri* from 40 tree species belonging to 30 plant families (Roberts, 1976)), the larger platypodid rarely attacks main stems below about 15 cm diameter; *C. externe-dentatus* is not size selective, attacking stems of from 5 to 50 cm diameter. Naturally *P. gerstaeckeri*, unlike the smaller species, is commonly found attacking felled trees in very large numbers, entrance holes being closely grouped together. When this occurs *C. externe-dentatus* is usually present only in small numbers, or completely absent. This suggests the larger platypodid produces a repellant pheromone, which has the effect of reducing competition for hosts, and nest space, by other ambrosia beetles. Attack by both species on living trees always apparently fails, beetles being killed by gum exudation produced by the mahogany, and breeding never occurs. Though holes are occluded by subsequent cambial growth, the mainly short galleries made remain within the stem, and on conversion are seen as numerous holes on the cut surface. This causes heavy degrade of the timber.

In plantations, attack by *C. externe-dentatus* is much more widespread than by *P. gerstaeckeri*. This results partly from the size selection shown by the large species; but also the greater aggressiveness of the smaller platypodid must contribute toward the difference. Trees under five years of age are not usually attacked, but older trees of all ages may suffer from *C. externe-dentatus*. Possibly late in the rotation, when mean stem diameter will be much greater (the oldest plantation in 1973 was only 11 years old), *P. gerstaeckeri* will be more important than it is now.

Observation difficult

Evidence of fresh, active attack is not easy to find. That seen was always associated with interference, or actual destruction of the plantations' vegetation matrix. Most common was attack on marginal trees of compartments.

Where this occurred invariably roadwork had been carried out nearby, though trees were never obviously damaged.

Inside plantations attack nearly always related to some forest operation such as thinning, pruning, cleaning, or the local removal of sample trees for experimental purposes. When it appeared, attack occurred within one to three weeks of the beginning of the operation and fresh attack would continue if the vegetation matrix was drastically changed, as with heavy cleaning, for up to five months after the operation ceased. The number of trees attacked, and the abundance of *P. gerstaeckeri* in particular, appeared to relate directly to the intensity of cleaning. It was found that attack could easily be induced by intensively cleaning half-acre plots of plantation. When this was done it was noticeable that large indigenous trees left standing among the mahogany were never attacked. Though heavy attack was associated with forest operations, very light attack was seen well inside plantations, where no operations had occurred during the previous six months. A monthly survey of four such sample blocks (each of 200 trees) chosen in each of three of the main plantation areas (Ngaloa, Colo-i-Suva, Nukurua) revealed light attack in every month of the year (May 1973-April 1974) by *C. externe-dentatus*. Except at Nukurua no more than 5 percent of the total number of trees sampled in each plantation were attacked in any one month.

Within plantations attack is apparently related to site. Among trees from twelve sites chosen in 1973 to represent variations in conditions in the 1965 Ngaloa Plantation, high mean attack levels were obtained from trees located where drainage was obviously bad (1.653 holes/board super foot), where vegetation indicators, e.g. giant ferns, suggested soil conditions were poor (1.523 holes/board super foot) and where a hurricane (1972) had caused extensive damage (1.240 holes/board super foot). These figures are much higher than those obtained for large trees from well-drained sites, which had comparatively fertile soils (0.130 holes/board super foot). On valley slopes trees located well up the slope were not as heavily attacked as those below them, though (because growth rates were lower) all were smaller in diameter than those in the valley bottom. At the base of slopes where growth conditions were apparently good it was not unusual to find trees of over 100 board super feet completely free of attack. At each site attack levels were obtained by felling trees at ground level, converting stems to half-inch boards, and counting the shot-holes on the cut surface. Figures quoted therefore represent old, subsurface attack.

High altitude

Small areas of mahogany, together with a hybrid (*S. macrophylla* × *S. mahogani*) have been grown at high altitude (900-1 100 m), near Nandarivatu, in the centre of Viti Levu. Examination of old attack in selected large stems from these plantations showed that the two beetles had attacked both *S. macrophylla* and the hybrid in the past but, compared with low altitudes, infestation was much lower.

Seasonal variation in attack is gen-

erally not to be expected in high-rainfall tropical rain forest conditions, but there was some evidence to suggest that attack was heavier during the months from October to March than at other times of the year. The surveys of current attack on the aforementioned blocks of 200 trees showed for Nukurua, where large plantations are grown under the lowest rainfall regime (including a weak dry season, according to Berry and Howard, 1973), a greater mean monthly level of attack than in the wetter plantations, with a peak in attack in February 1974. Though rainfall in all areas is high (3 050-3 800 mm+) all plantations experience short periods of up to a week without rain, and the chances of such short breaks in rainfall occurring are greater between August and December than at other times of the year. The flowering and fruiting of mahogany between October and December also are indirect evidence that the last three months are annually among the driest in Fiji. In the wild in South and Central America flowering and fruiting are said to be linked closely with the driest months (Lamb, 1966).

Rot

In Fiji *S. macrophylla* suffers infestation by three kinds of butt- or stem-rot, one termed " marginated butt-rot" and not easy to recognize, and two others, *Armillaria* and *Fomes*. In plantations obviously diseased trees were always seen to be heavily attacked, but, based on examination of freshly felled stumps, it would seem that in some localities the prevalence of rot may be greater than evidence from tree condition alone suggests. If incipient rot occurs, attack by ambrosia beetles may be expected.

The practice when establishing new plantations was to precede planting by poisoning indigenous trees. In many instances poisoning was extensive, but at the same time it was only partially effective, many trees being still alive one or two years after treatment. Three common trees — *Dillenia biflora* (Dilleniaceae), local name, kuluva, *Myristica castaneifolia* (Myristicaceae), local name, kaudamu, and *Pagiantha thurstonii* (Apocynaceae), local name, tadalo — are all very resistant to poisoning, and therefore difficult to kill. It was common to find stems of these still alive five to seven years after treatment. Poisoned trees are heavily attacked by a wide variety of ambrosia beetles, including in Fiji the two non-selective Platypodidae which attack mahogany. Where trees are properly killed the abnormal rise in ambrosia beetle population which follows poisoning will fall after four years, as all suitable breeding material disappears. Where, however, trees die very slowly they remain active breeding sites for much longer. Young beetles emerging from these trees will attack any planted mahogany surrounding them, provided it is not less than five years old; also any older plantations that may occur nearby will be vulnerable. Of the three trees resistant to poisoning, *Myristica* in particular was often seen with heavy infestations of ambrosia beetle within mahogany plantations. Two other sources of breeding material exist in the plantations. Thinnings and prunings are commonly left on the plantation floor. This mahogany is quickly attacked, and both Platypodidae readily breed successfully in it. Hurricanes, not uncommon in Fiji, also leave large quantities of material suitable for breeding. In strong winds it is not only the mahogany that suffers; often they in fact escape complete uprooting. More vulnerable are the much taller indigenous trees left in the plantations. Large populations of ambrosia beetles quickly develop in the latter.

Natural controls

Natural controls for both *C. externe-dentatus* and *P. gerstaeckeri* exist in the rain forest of Fiji. Gummation is commonly responsible for heavy mortality among males of the smaller species in felled, fallen, or injured trees. A limited variety of predators and nest parasites attack both species. The wood-swallow (*Artamus leucorhynchus*) was seen taking swarming adult *C. externe-dentatus* in flight, and on arrival on the host tree the same platypodid was taken by a skink (*Emoia samoensis*), and the larger species by a gekko (*Cyrtodactylus pelagicus*) and more commonly by an insect predator, *Omadius lividipes* (fam. Cleridae). Inside nests of *C. externe-dentatus* the brenthid nest-parasite *Cyphagogus fijianus* was sometimes found breeding, and in nests of *P. gerstaeckeri* larvae and adults of a colydiid beetle, *Nematidium* sp., were commonly found feeding on both larvae and young adults of the platypodid. These various mortality factors are however ineffective in limiting numbers of Platypodidae in the artificial situation represented by the mahogany plantation, which so favours the ambrosia beetles.

Living trees

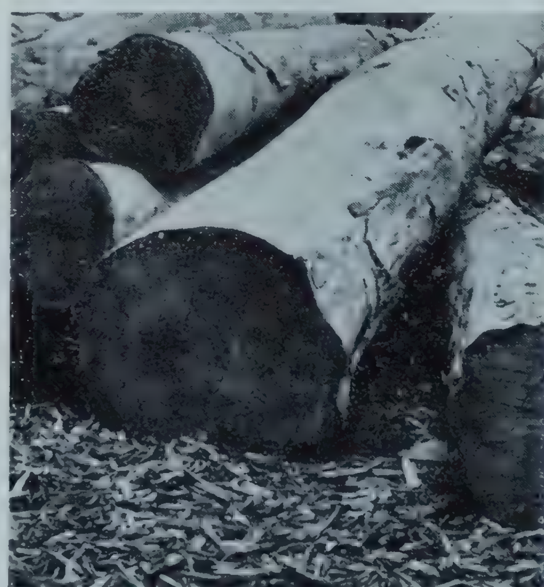
Attack by Platypodidae on living, apparently healthy, trees is unusual. Although three species (*Austroplatypus confertus* in Australia; *Bendroplatypus impar* in Malaysia; *Trachyostus ghanaensis* in Ghana and Ivory Coast) are known which attack only living trees, the intensity of attack is always low, and all breed successfully within the living tree. One species only, *Doliopygus dubius* in Nigeria, is known to attack regularly in large numbers and to breed within standing trees (host — *Terminalia superba* (Combretaceae) and at the same time to breed within a wide variety of felled trees. More common among Platypodidae is unsuccessful attack in large numbers on standing trees of reduced vigour (Browne, 1965). This habit has been recorded however only from areas which undergo a regular dry season, attack coinciding with the arrival of the dry weather. The pattern of attack shown by *C. externe-dentatus* and *P. gerstaeckeri* suggests attacked trees are of reduced vigour, but the loss in vigour does not coincide with any obvious period of dry weather. Perhaps *S. macrophylla* in some way is not fully adapted to the environment found in the area of Fiji in which it is grown. Trees in such a condition will show stress symptoms in response to temporary changes of the environment, and under stress produce chemicals attractive to ambrosia beetles. Non-selective species, such as *C. externe-dentatus* and *P. gerstaeckeri*, are the Platypodidae most likely to respond to attrac-

tants produced by an exotic tree. Evidence that *S. macrophylla* is poorly adapted is suggested by the absence of attack on indigenous trees compared with the heavy attack on some mahogany in areas of intensively cleaned plantation. It is known that very slight, temporary changes in climate, above or below the ground, can lead to stress symptoms in pines, which are followed by bark beetle attack (Barlow, 1966). In the virtually non-seasonal climate where mahogany is grown perhaps the very short periods without rain are in some way associated with production of stress symptoms. It was noticeable that, provided the tree retained a partial root system, windblown mahogany was often not attacked, possibly because its foliage remained in the comparatively stable climatic zone near the ground, and so was not exposed to the climatic variations crowns normally suffer from. The root systems of many eight-year-old trees were exposed and though they were apparently adequate, most lacked the taproot found in indigenous rain forest tree species. Where butt-rot occurs poorly adapted trees will be more likely to show stress symptoms, and so be more attractive to ambrosia beetles. Presumably one reason *C. externe-dentatus* is the most widespread pest is that it is more sensitive to attractants put out by a stressed tree, and therefore trees under only little stress are unlikely to be attacked. The very early arrival of this platypodid at felled trees indicates it is very sensitive to attractants.

Expensive lessons

Economically, the possible depredations and effects on quality by ambrosia beetle attack are potentially very serious. Based on 1973 values, the present mahogany plantations should produce a revenue of about F$23 million, but if beetle attack is extensive the financial return could be reduced by some two thirds. At the moment one of the problems is lack of knowledge on the extent of attack within the area at present under mahogany. Platypodid attack on living exotics would appear to be an expanding problem in the west Pacific, and perhaps elsewhere in the tropics as well.

In Fiji the same insects are also known to attack living *Eucalyptus* species (Myrtaceae), *Khaya anthotheca* (Meliaceae), *Nauclea diderrichii* (Rutaceae), and *Terminalia superba* (Combretaceae), but luckily none of these as yet occupy large areas (Alston, pers. comm.). *C. externe-dentatus* is also reported to attack *S. macrophylla*, and two species of *Eucalyptus* in Samoa (Beaver, 1976). Surprisingly, neither felled nor standing plantations of pines are attacked, though felled indigenous conifers of the same plant family are heavily attacked by both platypodids, for example *Agathis vitiensis* (fam. *Pinaceae*).



MAHOGANY LOGS
worth research

In Fiji the long-term solution to the problem demands more research into the exact requirements of *S. macrophylla*. Also, a detailed examination of the extent and levels of infestation by the different butt-rots in plantations needs to be made. Immediate remedies, all of them silvicultural, which can be taken must aim to greatly reduce breeding sites available to both Platypodidae, and at the same time to ensure a healthier crop of trees. Where timber contractors have been working, an interval of five years should elapse before the area is planted up. This would give sufficient time for the inevitable build-up in ambrosia beetle population to subside. The present practice of wholesale poisoning of logged forest as one of the initial stages of plantation establishment should be more effectively carried out. Fewer trees need be poisoned, and these inspected at six-monthly intervals over two years to see that they die. Species difficult to kill, particularly kaudamu (*Myristica* sp.), could be felled rather than poisoned. It is also important that poisoning not be carried out in areas where plantations more than five years old already exist. In the management of plantations it is most important that thinnings and prunings not be left lying on the floor. In the long term it would be better to collect and sell them, at a loss if necessary; there is a local demand for firewood and poles. Likewise, where hurricane damage occurs efforts should be made to remove windblown stems by burning, clearing, or sale of timber. After plantations have been established it is important to disturb trees as little as possible by forest operations. Attack on compartment margins may well have to be accepted, but within compartments cleaning and thinning operations should be reduced to a minimum, and, when necessary, vegetation at the base of individual trees should always be left or not reduced below a metre in height. ■

References

BARLOW, A.R. 1966 *The relationship between resin pressure and Scolytid beetle activity.* Forestry Commission; Forestry Record No. 57, Her Majesty's Stationery Office, London.

BEAVER, R.A. 1976 The biology of Samoan bark and ambrosia beetles (Coleoptera: Scolytidae and Platypodidae). *Bull. ent. Res.*, 65: 172-184.

BERRY, M.J. & HOWARD, W.J. 1973 *Fiji Forestry Inventory.* Land Resource Study No. 12, Land Resources Division, England. 98 p.

BROWN, F.G. 1965 Types of ambrosia beetle attack on living trees in tropical forests. *Proc. XIIth Int. Cong. Ent.* p. 680.

GRAY, B. 1974 Forest insect problems in the South Pacific Islands. *Commonw. For. Rev.*, 53: 39-48.

LAMB, F.B. 1966 *Mahogany of tropical America.* Univ. of Michigan Press. 220 p.

MANG, M. & VINCENT, A.J. 1972 *A report of findings from an extent of damage survey in standing mahogany* (Swietenia macrophylla) *attacked by ambrosia beetle in Fiji.* Fiji Forest Survey and Inventory Rep. No 5. 17 p.

ROBERTS, H. 1976 (Ambrosia beetle attack (Coleoptera: Platypodidae) on established living mahogany (*Swietenia macrophylla*) in Fiji (with descriptions of two new Platypodidae). *Bull. ent. Res.*, 66.

SCHEDL, K.E. 1972 *Monographie Familie Platypodidae* (Coleoptera). 322 p. Den Haag.

ORDER FORMS *to be mailed to:* Distribution and Sales Section
FAO — Via delle Terme di Caracalla
00100 Rome — Italy

or to any of the FAO Sales Agents listed on the inside back cover

---

Distribution and Sales Section
FAO — Via delle Terme di Caracalla
00100 Rome — Italy

Name .... Street ....

Occupation .... City .... Country ....

Please enter my subscription to **unasylva** for a period of one year (price: $ 8.00 *)

Edition required: ☐ English ☐ French ☐ Spanish

Form of payment: ☐ Cheque enclosed ☐ Bank order ☐ Unesco coupons ☐ On receipt of invoice

---

Distribution and Sales Section
FAO — Via delle Terme di Caracalla
00100 Rome — Italy

Name .... Street ....

Occupation .... City .... Country ....

Please enter my subscription to **unasylva** for a period of one year (price: $ 8.00 *)

Edition required: ☐ English ☐ French ☐ Spanish

Form of payment: ☐ Cheque enclosed ☐ Bank order ☐ Unesco coupons ☐ On receipt of invoice

---

Distribution and Sales Section
FAO — Via delle Terme di Caracalla
00100 Rome — Italy

Name .... Street ....

Occupation .... City .... Country ....

Please enter my subscription to **unasylva** for a period of one year (price: $ 8.00 *)

Edition required: ☐ English ☐ French ☐ Spanish

Form of payment: ☐ Cheque enclosed ☐ Bank order ☐ Unesco coupons ☐ On receipt of invoice

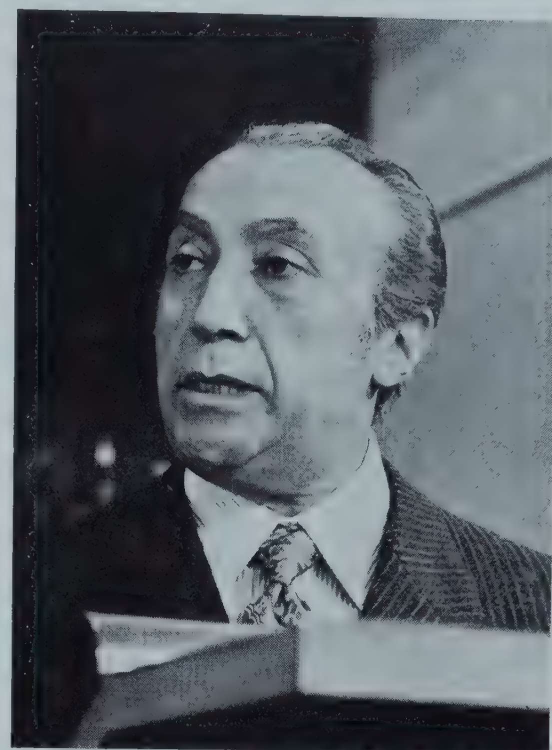
---

* *For subscription rates in your currency please check with your local FAO Sales Agent.*

B.R. Sen Award to Turkish forester

Talât Eren, a Turkish forester on the staff of the FAO Forestry Department, has received the B.R. Sen Award for outstanding service as head of a watershed management project in Thailand.

The award, which consists of a medal, a scroll and a prize of $2 000, is FAO's highest recognition for professional achievement. It was the second time that a forester was given the B.R. Sen Award. Kenneth Sargent, a British forester, received it in 1975 for his work in the planning and organization of forest industries in Malaysia. The award, which is conferred by the FAO Conference, the Organization's governing body, is named for Dr. B.R. Sen, of India, who was Director-General of FAO from 1956 to 1967.



Talât Eren

In the citation given to him, Eren, 56, was commended for "exceptional dedication and achievement" in his work in northern Thailand in aiding in the settlement of nomadic peoples, promoting better land-use practices on critical watersheds, increasing forest productivity and intensifying agriculture.

Mr. Eren worked in Thailand from 1973 to 1977. He is now Chief of the Forest Conservation and Wildlife Branch in the Forestry Resources Division of the Forestry Department.

Describing his work in Thailand he said that he realized early that the main task was to reach and convince the people, especially the rural poor, many of whom live in isolation. He and his assistants travelled extensively, visiting and talking to people, demonstrating rational land-use practices and better cropping systems. He assisted the Government in planning and building roads and infrastructure, and helped to set up a new Watershed Management Division within the Royal Forest Department.

Mr. Eren also organized a committee, comprising representatives of the royal family, monks, village headmen, schoolteachers and administrative representatives, to visit villages and to encourage people in the work.

Various innovations were introduced or expanded, such as the cultivation of fruit trees, coffee and tea, beekeeping and other quick cash-yielding activities. More fertile land on gentler slopes was allocated to families in exchange for fields where they had practised shifting cultivation. Assistance was provided in building terraces and in land conservation.

"We never imposed our views on the people," he said. "We showed what had to be done and how it should be done, and let the people take it up from there. Our own motto was: work as if you are staying here forever, but plan as if you are leaving tomorrow."

8th World Forestry Congress asks for Country Reports

The organizers of the 8th World Forestry Congress to take place in Djakarta in October are calling for more reports on the state of forestry nations of the world.

The third Circular Information Letter reporting preparation of the Congress, issued by Mr. Soedjarwo, Director-General of the Indonesian Forest Service and Chairman of the Congress Organizing Committee, said that not enough country reports had been received. Position papers and discussions of the Congress, said the letter, are liable to be "too academic" without the background contained in country reports on the actual conditions, progress and plans for forestry on national levels.

The Congress is scheduled to take place in the Djakarta Convention Hall from 16 to 28 October 1978. It will be preceded and followed by study tours. An attendance of about 2 000 is expected.

The theme of the Congress is "Forestry for People." Under this theme there will be five areas of discussion: Forestry for Rural Communities, Forestry for Food, Forestry for Employment Promotion, Forestry for Individual Development and Forestry for Quality of Life.

The 3rd Information Letter also asked governments to send in "at your convenience" suggestions for

inclusion in the Congress Declaration. These points should be related to the Congress theme or one of the five major discussion areas. A draft Declaration will be submitted to the Congress Panel on the morning of the last day of the Congress, 28 October.

Copies of country papers as well as suggestions for the Congress Declaration should be sent to the Secretary-General and the Associate Secretary-General of the Congress. Country reports should be sent in duplicate to each of these officers. They are:

Mr. LUKITO DARYADI
Secretary-General
8th World Forestry Congress
P.O. Box 3668/JKT
Djakarta, Indonesia

Mr. OSCAR FUGALLI
Associate Secretary-General
8th World Forestry Congress
Forestry Department
FAO
Via delle Terme di Caracalla
00100 Rome, Italy

The circular letter also gave details concerning exhibits. Depending upon size of individual stands, there are accommodations for 36 to 50 exhibitors in the Convention Hall. There will be four categories of exhibits:

- Forest products of an international character.
- Information about equipment for the manufacture of forest products. These could include models, audio-visual presentations, posters, brochures and similar information material.
- Photographic displays. These should show activities related to the theme, sub-themes or discussion areas of the Congress, or to the general development of forestry on the national level.
- A furniture fair.

With the exception of the furniture fair, the exhibits will be housed in the Convention Hall. The furniture fair will be held in the Djakarta Fair Grounds. Exhibits involving the projection of colour slides are encouraged.

Rental costs for exhibits will be about US$50 or Indonesian rupiahs 20 000 per square metre. Electric current in the Convention Hall is 1.3 to 2 kW of 220 volts, 50 cycles.

The original plans for a film festival during the Congress have been dropped but the organizers are still anxious to obtain recent films on forestry, especially if they are related to subjects to be discussed at the Congress. Films will be shown on nights when social events are not scheduled.

One-year timber course

In recent years the Timber and Materials Section of the Department of Art Design (Furniture and Timber) at Buckinghamshire College of Higher Education have offered a one-year timber studies course for graduates or executives from the timber industry. It covers aspects of timber preparation, processing, trade practices and utilization. In addition students select a specialization for in-depth study, i.e., sawmilling or yard-handling.

Candidates who are successful in the Diploma Examination may be awarded passes at First or Second Class Honours as well as becoming eligible to be awarded Associate Membership of the Institute of Wood Science.

Overseas students may be supported by the British Council or FAO. Students from the U.K. may be eligible to receive TOPS grant awards while attending the College.

Further details of the course can be obtained from Mr. D.G. Patterson at the College, Queen Alexandra Road, High Wycombe HP11 2JZ, Great Britain. Telephone 22141, ext. 52.

International Symposium on Forest Meteorology

The World Meteorological Organization is sponsoring a symposium on forest meteorology to be held in Ottawa, Canada, 21-25 August 1978. The symposium is being hosted jointly by the Canadian Forestry Service and the Atmospheric Environment Service of Canada. The purpose of the meeting is to bring together scientists from all over the world who have a common interest in the scientific problems of forest meteorology as well as the applications of meteorology to forestry. Technical sessions are planned in the following areas:

- Effects of climate and climatic variability on world forest distribution.
- Applications of climatology in forestry planning.
- Applications of meteorology in forestry operations.
- Meteorology and climatology in relation to management of forest fires.
- Meteorology in forest disease and insect control.
- Impact of environmental factors (including pollutants, wind, temperature, precipitation, etc.) on forest development and forest production.
- Role of forests and wildlands in global and/or regional balances of heat, carbon dioxide, hydrocarbons, etc.

Each session will be introduced by an invited keynote speaker followed by presentation of individual relevant papers and/or panel discussions. The official languages of the symposium will be French and English with simultaneous interpretation.

To permit flexibility in scheduling of papers, and to allow for papers on topics not on the formal agenda, one or more "poster" sessions will be scheduled. In these sessions, scientists can present current research results on prepared posters and be available for discussions with interested symposium participants.

A field trip to the Maniwaki Fire Management Research Application and Testing Station is scheduled and other trips may be added.

The meeting will be held at the University of Ottawa in downtown Ottawa. Low-cost dormitory accommodations will be available and additional hotel and motel accommodations are nearby. Sightseeing programmes for accompanying spouses are also being arranged.

For further information on submission of papers and abstracts, contact the Symposium Director, Professor William E. Reifsnyder, School of Forestry and Environmental Studies, Yale University, Marsh Hall - 360 Prospect Street, New Haven, Connecticut 06511, U.S.A. Phone (203) 436-0020.

For information on accommodations, contact the Arrangements Coordinator, Dr. James B. Harrington, Jr., Forest Fire Research Institute, 240 Bank Street, Ottawa, Ontario K1G 3Z6, Canada. Phone (613) 996-0811.

ECE/FAO Agriculture and Timber Divisions merged

The joint Agriculture and Timber Divisions of the United Nations Economic Commission for Europe (ECE) and the Food and Agriculture Organization of the United Nations (FAO) were merged on 1 January 1978.

Eero F.I. Kalkkinen, Director of the ECE/FAO Timber Division since 1963, and a member of the staff of FAO since 1948, heads the new ECE/FAO Agriculture and Timber Division. Peter Meihsl has been named Deputy Director of the new division, and Chief, Agriculture Section. Timothy Peck has been appointed Chief, Timber Section.

The ECE secretariat in Geneva now consists of the following nine divisions: agriculture and timber; energy; environment and human settlements; general economic analysis; industry, projections and programming; statistics; trade and technology; transport.

Finger-jointing for green lumber

Scientists at Canada's Western Forest Products Laboratory (WFPL) in Vancouver, British Columbia, have developed a method of finger-jointing which they say is simpler and cheaper than methods used up to now and which can be employed on green lumber.

The following description of the new method is from an article by Miles Overend appearing in *Canadian Forest Industries* magazine.

* * *

The new finger-jointing technique, for which patterns are pending, would make possible the upgrading of green lumber shorts into longer structural members. At the present time the radio-frequency method of making finger joints can only be used with kiln-dried lumber and in addition is not suitable to some species of wood, such as those from the interior of British Columbia.

The method was developed by the Adhesives Research Group of the Western Forest Products Laboratory, under Dr. Suezone Chow. The group has been working for the past six years on problems connected with the gluing of wood products such as plywood and laminated beams.

Current methods of finger-jointing are expensive, and, in the case of some species, uncertain. As a result, in Canada only Douglas fir and western hemlock, two species from the coastal area of British Columbia, have been found suitable for the radio-frequency method. Initial research into the problems connected with the use of other species showed that the heat build-up in the bonding agent resulted in burning and consequent weakening of the joint. The ability to make finger joints in green wood, which would pass structural tests, could result in millions of dollars saved in salvaged short ends.

Under the present radio-frequency method of finger-jointing, the lumber must be dried to a 10 percent moisture content before the finger-jointing process can be applied.

After drying, lumber is put through the finger-jointing machine which cuts the fingers. Then the joint is fitted and glued and the whole assembly is passed through a radio-frequency field under a pressure of 400 to 600 psi.

In the new WFPL method, the green lumber is cut on the finger-jointing machine, heated for ten minutes at 160°C, then cooled, and the glue applied with an end pressure of 600 psi. Heat stored in the wood is transferred to the fingers to cure the joint.

No radio-frequency curing is needed, and the pre-heating needs only to be applied to the finger joint itself, not the whole piece of wood. In fact all that's needed for the bond is a moisture content of not more than 50 percent in the fingers themselves.

Several Canadian companies are interested in the new process, and it's likely a pilot plant will be built in the near future. One interior sawmill is already negotiating for a finger-jointing line for spruce-pine-fir stud lumber.

Studs from the company were sent to WFPL to be finger-jointed and tested according to Canadian Standards Association standards. Their minimum bending strength was 2.55 times the allowable unit stress for select (structural grade) lumber. The combined average bending strength for the tests in narrow and wide faces of lumber was 3.57 times greater than the unit stress for select structural grade. Minimum tensile strength of the finger-jointed lumber was 2.2 times the unit stress for select structural grade lumber, and the average tensile strength was 3.83 times that for select structural grade.

Road building and harvesting course in Austrian mountains

The Second FAO/Austria Training Course on Forest Roads and Harvesting in Mountainous Forests will be held at Ort and Ossiach, Austria, from 3 June through 3 July 1978.

The programme is designed for teaching technical and economic aspects of road building and harvesting in mountains through lectures, practical training, demonstrations and study trips. Emphasis will be put on road planning, construction and maintenance, and wood extraction with modern techniques. Reduction of harmful effects on soil and stands will be among the considerations. The month-long course is arranged with lectures in the mornings and field work in the afternoons.

Applicants for the 35 places should be professional-level foresters from developing countries, with or without university training. They should be actively engaged in forestry. In selecting candidates preference will be given to younger foresters with at least two years' experience and especially those who are likely to put what they learn to use in supervisory capacities.

The first course of this kind jointly sponsored by the Austrian Government and the FAO was held in 1975. It is foreseen that it will be repeated at two-year intervals.

Further information may be had from Rudolf Heinrich, Forestry Department, FAO, Rome, who is in charge of organizing the course.

Computers in the pulp and paper industry

Terminology, equipment, concepts, utilization, viability

ROGER L. GRANT. *Introduction to the terminology, equipment and concepts of computers, as illustrated by practice in the pulp and paper industry*. New York, Lockwood Publishing Co., Inc., 1971. 152 pages.

Converting wood to paper for the consumer is a long and many-staged process. To begin with, to succeed financially, the paper maker needs a wealth of up-to-date information about procurement of wood, pulping, bleaching, refining, running the paper machine, the trade, etc. Next, the data must be codified and condensed in a form allowing for guick decisions and their immediate implementation. This generates a huge task of data collection, data processing and process control. At first, the industry tried to solve these problems through human resources alone, later by means of various kinds of analog controls and, from the beginning of the sixties, by using digital computers.

Thanks to its versatility, the computer has won a permanent position in the pulp and paper industry. Now, in the mid-seventies, a wood processing industry is considered old-fashioned if its essential operations are not handled by a computer, and this imposes certain requirements on the training of people working in these industries. A papermaker today has to acquaint himself with automatic data processing and methods, and with the equipment used for that purpose, as well as its possibilities.

Several textbooks have been written on the subject of data processing, but most are only marginally interesting. Roger Grant's book, *Introduction to the terminology, equipment and concepts of computers*, is the first of its kind dealing with computers, computer terminology and their possibilities of use, prepared for people working in the pulp and paper industry: Dr. Grant is quite at home here, and this is clearly apparent in his book. A pulp and paper engineer is definitely going to read it with greater interest than other works.

This is how the author defined what he set out to do:

- " A comprehensive, but elementary, introduction to the equipment, practice and concepts of the principal forms of computer."
- " A means of obtaining a working vocabulary consisting of 380 of the specialized terms (" buzz words ") most commonly used in connection with computers."
- " The first book for the pulp and paper industry on computers, and the theory and practice of their applications."

The question is, then, how well has he done it?

The first two chapters, " Fundamentals of digital-process computers " and " Digital and analog computer hardware " form one complex.

To begin with, the computers are divided into four types: digital and analog process computers, business computers and scientific computers. The first chapter deals mainly with digital process computers, as they are the most complicated ones and also form the basis for presentation of the three other types of computers.

Only the main features of digital process computer hardware are dealt with in the first chapter, but the second chapter gives a more detailed presentation of this. There is a review of the presentation of data and numbers in the computer as well as of the principles of computer control — although the reader is not taught to run or programme computers. The presentation is a logical listing of facts accompanied by explanatory charts, pictures and examples.

Chapter Three, " Fundamentals of control theory, " is a much needed review of the mathematical methods required for process control which forms an introduction to examples of their application. Grant poses the reader's question: " Given all the wonderful hardware and software described in the first two chapters, how does one unravel the complex interrelationships that exist in the manufacturing process, and then present them in forms such as the computer can, not only control, but also optimize the

process?" His answer is: "Control theory attempts to provide the answer. It is an area rich in mathematical jargon, but fortunately it is possible to cover the main aspects conceptually without going into the mathematics." This answer illustrates how the control theory is presented in the book.

The chapter "Types of computers" reviews the rôle of the various types, such as minicomputers, business computers and scientific computers. In addition, there is a well illustrated presentation of the four main types of process control systems: conventional, open loop, supervisory and direct digital control.

Viability

Chapters One, Two, Three and Four do not require the reader's previous knowledge of pulping and papermaking. However, a prerequisite for understanding the following chapters (Five to Eight) is a basic insight into the pulping and papermaking processes. In Chapter Five, "Woodland through bleach plant," the economic viability of computerization and the measurement of economic viability are discussed, and some common misunderstandings of viability estimates are straightened out.

The book presents some computer applications for wood procurement. The most famous of these is, perhaps, the system developed by the Canadian International Paper Co., called "Continuous Forest Control". More detailed examples are given for pulp mills using batch and Kamyr digesters and for bleach plants. The successful use of a minicimputer by the Finnish firm of Oy Wildh. Schauman Ab is given as a model of a system based on a batch digester installation.

Another example, a Kamyr digester installation, is taken from the Demopolis mill of the Gulf States Paper Corp. The control of bleach plants is dealt with at length, together with some information about the installation at the Naheda mill of the American Can Co.

The chapter "Computer applications: stock preparation through shipping," centres on stock preparation and computer control of the paper machine, which is dealt with in detail, with special emphasis on control of grammage and quality changes. In this context management information systems and production planning, including trimming problems, are reviewed and a number of mills with successful installations are cited.

Chapter Seven; "Computer applications: supporting mill departments", deals briefly with application of computers in the recovery department, power plant and groundwood mill as well as with water and air pollution abatement. The last chapter, "Computer applications: business and EDP," lists interesting applications in the field of management operations and clarified basic concepts.

From the pulp and paper maker's point of view there is no doubt that the last four chapters are the most interesting. The lengthy papermaking process is dealt with stage by stage, presenting at each stage the application of computers with reference to articles published in trade magazines and to papers submitted at conferences.

Hardware, software

The list of references provides a means for acquiring deeper knowledge of computer applications. A great number of articles have been published on the use of computers in the pulp and paper industry and the selection of the best ones for reference purposes is a difficult task, but the author seems to have succeded in this. At least the references include those which were of major interest before 1971. The examples given of more detailed presentations of computer installations from the late sixties are all very good. Of course, six years have passed since this book was published and now more material is available. There has been a lot of development recently, especially in the control of the groundwood process.

A two-part appendix gives a summary of an industry carried out in 1970 by Paper Trade Journal in the United States and Canada into the use of computers in the pulp and paper industry. The first part "traces the growth of the different classes of computer, records the general characteristics of some profitable installations, and describes hardware and software practice." The second par "covers the nature of installations by mill departments." This summary constitutes a good illustration of the situation in North America in 1970.

"Buzz words"

Another appendix, "Glossary of basic computer terms," is for people who come into contact with computers and process control. It contains 380 "buzz words" in alphabetical order. After each term, there is a short definition. The author aims at giving capsule explanations rather than rigidly correct definitions. In addition, there are also references to the main text which explains the meaning of some of the terms in more detail. For instance, the term "best operator" is defined as follows: "control approach whereby the mode of operation of the best shift crew (or smaller unit of operators) is used as a control model." A very clear definition. On the other hand, the term "z-transform" is defined as a "technique for changing the discontinuous equivalent of differential equations into normal algebraic form. Cf.: Laplace transform." The z-transform is used for this purpose, but if one wants to find out what a z-transform is, no answer is given, either in the text or in connection with the Laplace transform, which also lacks an explanation. Moreover, no reference books relating to such transforms are mentioned.

To conclude, the author succeeded in most of his objectives. The book gives the basic general information on computers and the concepts immediately related to them, with the process computer at the centre. The systematic presentation, deliberately restricted to those concepts which were essential to the book's aims, makes it easy to read. The glossary helps the reader find what he is looking for. However, the value of the explanations of mathematical concepts, in his work on specialized words, is somewhat in doubt.

PERTTI LAININEN
Helsinki University
of Technology

THOMAS M. MALONEY. *Modern particleboard and dry-process fibebroard manufacturing*, Miller Freeman Publications, Inc., San Francisco, California, 1977, 672 pages, $42.50.

Dealing with a relatively new and increasingly important branch of the forest products industry, *Modern particleboard and dry-process fibreboard manufacturing* presents in one volume a wealth of practical information about today's board processing systems and the range of products manufactured from comminuted wood.

The book's emphasis is on dry-process methods and technology for producing platen-pressed boards, with special attention to dry-process hardboard, medium-density fibreboard, and particle board — three important products with similar basic production techniques. Extruded board, moulded products, and mineral-bonded products, minor parts of the industry in the United States and Canada, are discussed.

One of North America's leading authorities on particleboard and fibreboard manufacturing, Thomas M. Maloney is well qualified to write a comprehensive manual for those who want to know about composition board processing and products. He is head of the Wood Technology Section, Department of Materials Science and Engineering at Washington State University and has spent 21 years on research and development of hardboard and particle board.

Among the subjects covered are particle generation, conveying, and storage; drying practices; moisture measurement and control; particle separation; fire and explosion prevention; resins and other additives; resin wax application; caul and caulless systems; mat forming; pre-pressing; hot pressing; and primary and secondary board finishing. Processing equipment is also examined.

Throughout his text, Maloney has deliberately de-emphasized the highly technical, scientific, and theoretical aspects of dry-process board in favour of providing useful, practical information for anyone involved in the forest products industry.

The book gives both English and metric measurements, with conversion tables. There are some 460 illustrations, a bibliography and an index.

unasylva manuscript style

unasylva
an international journal of forestry and forest industries, is published quarterly in English, French and Spanish editions.

Language and writing style

Manuscripts are accepted in English, French or Spanish. Well-organized and clearly written manuscripts not only help to communicate ideas and information to the reader, but they facilitate editing and translation.

Manuscript preparation

Manuscripts should be in duplicate, typewritten double-spaced on one side of the page only and with wide margins. About 250 words to a page will simplify word-count estimates. It should be possible for us to make clean, easily read photocopies from any manuscript, therefore please use a new typewriter ribbon. The first page should have in the upper right-hand corner the author's name and address, the date and the number of words in the main text, not including words in tables, figures, captions or titles. Subsequent pages should have only the author's name in the right-hand corner.

Metric system

All measurements should be in the metric system.

Tables, figures, drawings

Tables, figures and drawings of any kind should each be on a separate page and numbered to correspond to their points of reference in the text. They should never be pasted into the body of the text. They should be as clear and simple as possible. Only essential tables and figures should be included and all should be identified as to source.

Photographs

unasylva uses black-and-white photographs. We prefer good quality black-and-white prints 18 × 24 cm (8 × 10 in) on glossy paper. If a diapositive colour-slide is of high quality we may be able to make a copy negative from it and a good quality black-and-white photograph, but we prefer not to have them. We will make every effort to return colour slides and black-and-white negatives but we cannot guarantee return. Black-and-white prints are not returned.

Footnotes and references

Footnotes and references should be listed on separate sheets at the end of the manuscript. Footnotes should be kept to an absolute minimum and we prefer none. References should be strictly relevant to the article and should also be kept to a minimum. For style of references please see examples in the magazine.

Length

Long articles are 3 000 to 4 000 words, and short articles are 750 to 2 000 words.

Republished articles

unasylva prefers original articles but does not rule out reprints, especially where there is the possibility of exchanging views and developments of basic importance in forestry and forest industries between readers in developed and developing regions of the world or where language considerations are involved.

Queries in advance

We welcome letters from writers suggesting ideas and subject matter for proposed articles. They usually result in articles of a higher quality and in a saving in writing and editing time.

Who are the readers?

unasylva subscribers in some 135 countries fall into the following broad categories:

— Government officials, in particular the executive level of national forest services, wildlife departments and national parks. This also includes delegates and missions attached to the United Nations and its specialized agencies and staff members of international organizations dealing with forestry, environment, forest industries and trade.

— Forestry schools and institutes, both through their libraries and subscriptions to individual staff members.

— Forest industry companies dealing with services for forestry, companies dealing in forest products.

— Individual professional foresters, especially those concerned with international forestry.

— Editors of professional and trade journals dealing with forestry, forest industries and environmental conservation.

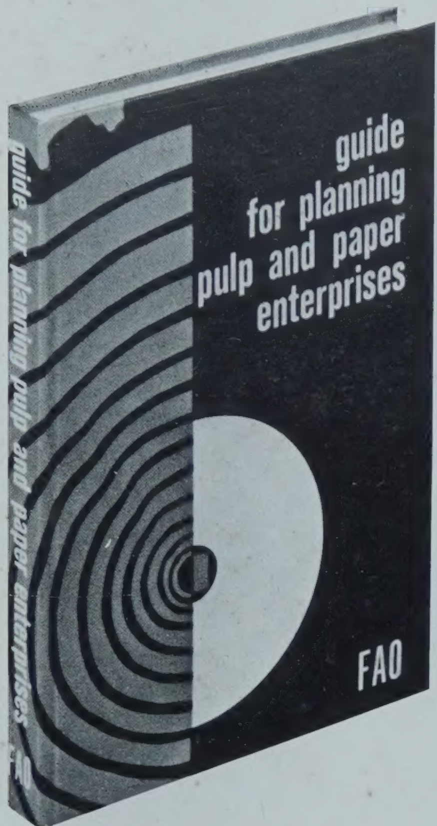
FAO SALES AGENTS AND BOOKSELLERS

Antilles, Netherlands	Boekhandel St. Augustinus. Abraham de Veerstraat 12, Willemstad, Curaçao.
Argentina	Editorial Hemisferio Sur S.R.L., Librería Agropecuaria, Pasteur 743, Buenos Aires.
Australia	Hunter Publications, 58A Gipps Street, Collingwood, Vic. 3066 ; The Assistant Director, Sales and Distribution, Australian Government Publishing Service. P.O. Box 84, Canberra, A.C.T. 2600, and Australian Government Publications and Inquiry Centres in Canberra, Melbourne, Sydney, Perth, Adelaide and Hobart.
Austria	Gerold & Co., Buchhandlung und Verlag, Graben 31, 1011 Vienna.
Bangladesh	Agricultural Development Agencies in Bangladesh, P.O. Box 5045, Dacca 5.
Barbados	Cloister Bookstore Ltd., Hincks Street, Bridgetown.
Belgium	Service des publications de la FAO, M.J. De Lannoy, rue du Trône 112, 1050 Brussels. CCP 000-0808993-13.
Bolivia	Los Amigos del Libro, Perú 3712, Casilla 450, Cochabamba ; Mercado 1315, La Paz ; René Moreno 26, Santa Cruz ; Junín esq. 6 de Octubre, Oruro.
Brazil	Livraria Mestre Jou, Rua Guaipá 518, São Paulo 10; Rua Senador Dantas 19-S205/206, Rio de Janeiro.
Brunei	MPH Distributors Sdn., Bhd., 71/77 Stamford Road, Singapore 6 (Singapore).
Canada	Renouf Publishing Co. Ltd., 2182 Catherine St. West. Montreal, Que. H3H 1M7.
Chile	Biblioteca, FAO Oficina Regional para América Latina, Av. Providencia 871, Casilla 10095, Santiago.
China	China National Publications Import Corporation, P.O. Box 88, Peking.
Colombia	Litexsa Colombiana Ltda., Calle 55, Nº 16-44, Apartado Aéreo 51340, Bogotá.
Costa Rica	Librería, Imprenta y Litografía Lehmann S.A., Apartado 10011, San José.
Cuba	Empresa de Comercio Exterior de Publicaciones, Obispo 461, Havana.
Cyprus	MAM, P.O. Box 1722, Nicosia.
Denmark	Ejnar Munksgaard, Norregade 6, Copenhagen S.
Dominican Rep.	Fundación Dominicana de Desarrollo, Casa de las Gárgolas, Mercedes 4, Santo Domingo.
Ecuador	Su Librería Cía. Ltda., García Moreno 1172, Apartado 2556, Quito.
El Salvador	Librería Cultural Salvadoreña S.A., Avenida Morazán 113, Apartado Postal 2296, San Salvador.
Finland	Akateeminen Kirjakauppa, 1 Keskuskatu, Helsinki.
France	Editions A. Pedone, 13 rue Soufflot, 75005 Paris.
Germany, F.R.	Alexander Horn Internationale Buchhandlung, Spiegelgasse 9, Postfach 3340, Wiesbaden.
Ghana	Fides Enterprises, P.O. Box 1628, Accra.
Greece	« Eleftheroudakis », 4 Nikis Street, Athens.
Guatemala	Distribuciones Culturales y Técnicas « Artemis », Quinta Avenida 12-11, Zona 1, Guatemala City.
Guyana	Guyana National Trading Corporation Ltd., 45-47 Water Street, Georgetown.
Haiti	Max Bouchereau, Librairie « A la Caravelle », B.P. 111B, Port-au-Prince.
Honduras	Editorial Nuevo Continente S. de R.L., Avenida Cervantes 1230-A, Apartado Postal 380, Tegucigalpa.
Hong Kong	Swindon Book Co., 13-15 Lock Road, Kowloon.
Iceland	Snaebjörn Jónsson and Co. h.f., Hafnarstraeti 9, P.O. Box 1131, Reykjavik.
India	Oxford Book and Stationery Co., Scindia House, New Delhi; 17 Park Street, Calcutta.
Indonesia	P.T. Gunung Agung, 6 Kwitang, Djakarta.
Iran	Iran Book Co. Ltd., 127 Nadershah Avenue, P.O. Box 14-1532, Tehran; Economist Tehran, 99 Sevom Esfand Avenue, Tehran (sub-agent).
Iraq	National House for Publishing, Distributing and Advertising, Rashid Street, Baghdad.
Ireland	The Controller, Stationery Office, Dublin.
Israel	Emanuel Brown, P.O. Box 4101, 35 Allenby Road and Nachlat Benyamin Street, Tel Aviv; 9 Shlomzion Hamalka Street, Jerusalem.
Italy	Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome; Libreria Scientifica Dott. L. De Biasio « Aeiou », Via Meravigli 16, 20123 Milan; Libreria Commissionaria Sansoni « Licosa », Via Lamarmora 45, C.P. 552, 50121 Florence.
Jamaica	Teachers Book Centre Ltd, 96 Church Street, Kingston.
Japan	Maruzen Company Ltd., P.O. Box 5050, Tokyo Central 100-31.
Kenya	Text Book Centre Ltd, P.O. Box 47540, Nairobi.
Korea, Rep. of	The Eul-Yoo Publishing Co. Ltd., 5 2-Ka, Chong-ro, Seoul.
Kuwait	Saeed & Samir Bookstore Co. Ltd., P.O. Box 5445, Kuwait.
Lebanon	Dar Al-Maaref Liban S.A.L., place Riad El-Solh, B.P. 2320, Beirut.
Luxembourg	Service des publications de la FAO, M.J. De Lannoy, rue du Trône 112, 1050 Brussels (Belgium).
Malaysia	MPH Distributors Sdn. Bhd., 9A Jalan 14/20, Section 14, Petaling, Jaya.
Mauritius	Nalanda Company Limited, 30 Bourbon Street, Port Louis.
Mexico	Dilitsa, Puebla 182-D, Apartado 24-448, Mexico City, 7 D.F.
Morocco	Librairie « Aux Belles Images », 281 avenue Mohammed V. Rabat.
Netherlands	N.V. Martinus Nijhoff, Lange Voorhout 9, The Hague.
New Zealand	Government Printing Office: Government Bookshops at Rutland Street, P.O. Box 5344, Auckland; Mulgrave Street, Private Bag, Wellington; 130 Oxford Terrace, P.O. Box 1721, Christchurch; Princes Street, P.O. Box 1104, Dunedin; Alma Street, P.O. Box 857, Hamilton.
Nicaragua	Incusa-Culturama, Camino de Oriente, Apartado C105, Managua.
Nigeria	University Bookshop (Nigeria) Ltd., University of Ibadan, Ibadan.
Norway	Johan Grundt Tanum Bokhandel, Karl Johansgt. GT 41-43, Oslo 1.
Pakistan	Mirza Book Agency, 65 The Mall, Lahore 3.
Panama	Distribuidora Lewis S.A., Edificio Dorasol, Calle 25 y Avenida Balboa, Apartado 1634, Panama 1.
Peru	Librería Distribuidora Santa Rosa, Jirón Apurimac 375, Lima.
Philippines	The Modern Book Company, 928 Rizal Avenue, Manila.
Poland	Ars Polona-Ruch, Krakowskie Przedmiescie 7, Warsaw.
Portugal	Livraria Bertrand, S.A.R.L., Apartado 37, Amadora; Livraria Portugal, Dias y Andrade Ltda, Apartado 2681, Rua do Carmo 70-74, Lisbon-2; Edicoes ITAU, Avda. República 46A c/v-E, Lisbon-1.
Romania	Ilexim, Calea Grivitei Nº 64-66, B.P. 2001, Bucarest.
Saudi Arabia	University Bookshop, Airport Road, P.O. Box 394, Riyadh.
Senegal	Librairie Africa, 58 Av. Georges Pompidou, B.P. 1240, Dakar.
Singapore	MPH Distributors Sdn. Bhd., 71/77 Stamford Road, Singapore 6.
Somalia	« Samater's », P.O. Box 936, Mogadishu.
Spain	Mundi Prensa Libros S.A., Castelló 37, Madrid 1; Librería Agrícola, Fernando VI 2, Madrid 4.
Sri Lanka	M.D. Gunasena and Co. Ltd., 217 Norris Road, Colombo 11.
Switzerland	Librairie Payot S.A., Lausanne et Genève; Buchhandlung und Antiquariat, Heinimann & Co., Kirchgasse 17, 8001 Zurich.
Surinam	VACO nv in Surinam, P.O. Box 1841, Domineenstraat 26/32, Paramaribo.
Sweden	C.E. Fritzes Kungl. Hovbokhandel, Fredsgatan 2, 103 27 Stockholm 16.
Tanzania	Dar es Salaam Bookshop, P.O. Box 9030, Dar es Salaam.
Thailand	Suksapan Panit, Mansion 9, Rajadamnern Avenue, Bangkok.
Togo	Librairie du Bon Pasteur, B.P. 1164, Lomé.
Trinidad and Tobago	The Book Shop, 111 Frederik Street, Port of Spain.
Turkey	Güven Bookstores, Güven Bldg., P.O. Box 145, Müdafaa Cad. 12/5, Kizilay-Ankara; Güven Ari Bookstores, Ankara Cad. No. 45, Cagaloglu-Istambul; Güven Bookstore, S.S.K. Konak Tesisleri P-18, Konak-Izmir.
United Kingdom	Her Majesty's Stationery Office, 49 High Holborn, London WC1V 6HB (callers only); P.O. Box 569, London SE1 9NH (trade and London area mail orders); 13a Castle Street, Edinburgh EH2 3AR; 41 The Hayes, Cardiff CF1 1JW; 80 Chichester-Street, Belfast BT1 4JY; Brazennose Street, Manchester M60 8AS; 258 Broad Street, Birmingham B1 2HE; Southey House, Wine Street, Bristol BS1 2BQ.
United States of America	UNIPUB, 345 Park Avenue South, New York, N.Y. 10010; mailing address: P.O. Box 433, Murray Hill Station, New York, N.Y. 10016.
Uruguay	Juan Angel Peri, Alzaibar 1328, Casilla de Correos 1755, Montevideo.
Venezuela	Blume Distribuidora S.A., Av. Rómulo Gallegos esq. 2a. Avenida, Centro Residencial « Los Almendros », Torre 3, Mezzanina, Ofc. 6, Urbanización Montecristo, Caracas.
Yugoslavia	Jugoslovenska Knjiga, Terazije 27-11, Belgrade; Cankarjeva Zalozba, P.O. Box 201-IV, Ljubliana; Prosveta Terazije 16, P.O. Box 555, 11001 Belgrade.
Other countries	Requests from countries where sales agents have not yet been appointed may be sent to: Distribution and Sales Section, Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla, 00100 Rome, Italy.

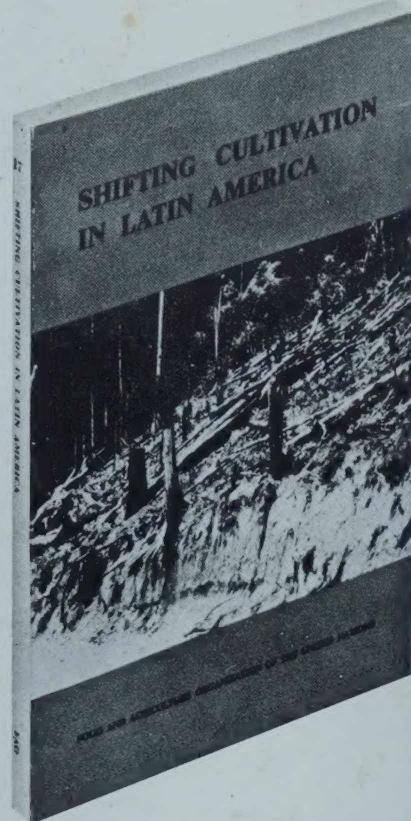
P/L0049/E/4.78/1/6000

Tip. F. Failli - Roma

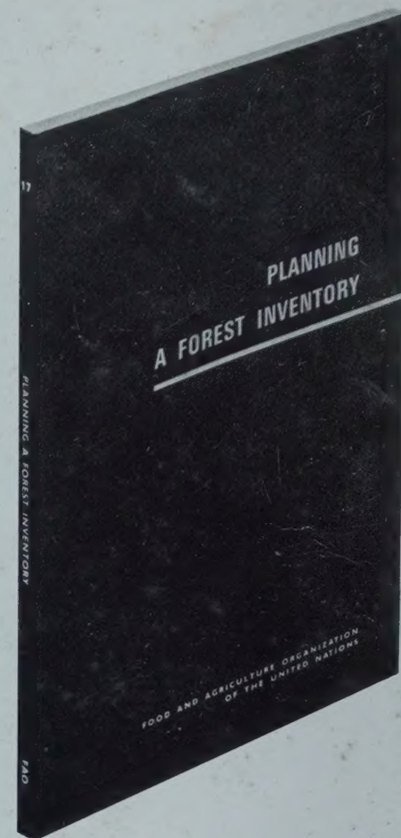
6 useful forestry titles from FAO



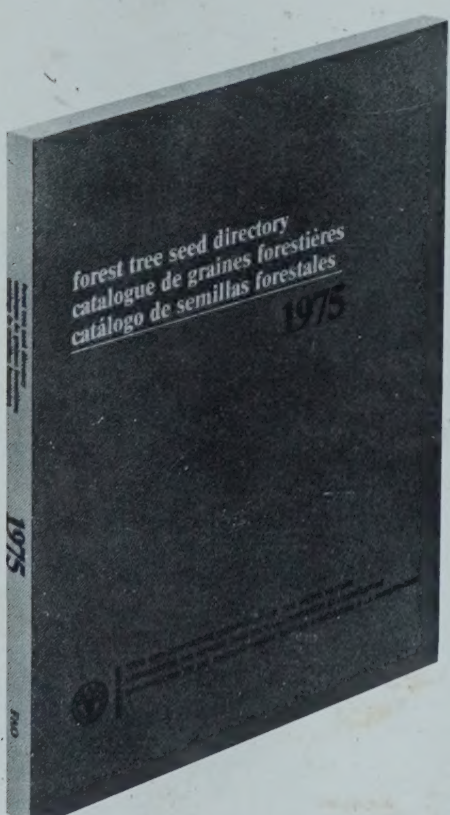
A study of planning functions, with technical information on raw materials and pulp and paper manufacture. English, French and Spanish editions.
379 pages, 26 ill., clothbound. $12.50 *



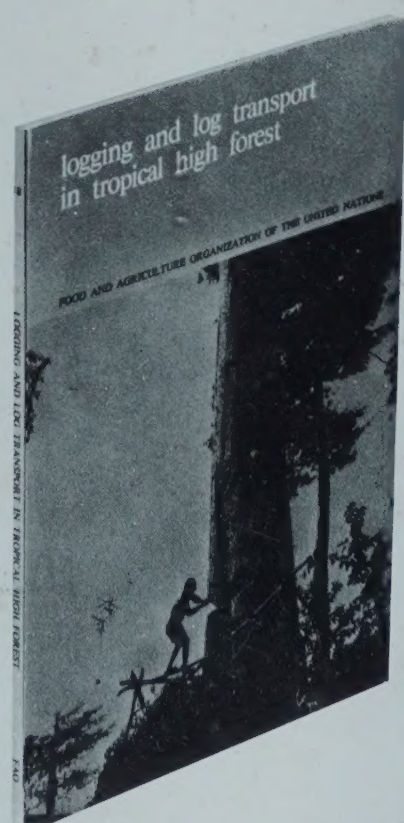
A study of shifting agriculture in Latin America, with particular emphasis on Venezuela, Mexico and Peru. English, French and Spanish editions.
305 pages, 19 ill. $8.00 *



A guide to the planning and execution of a forest inventory. English, French and Spanish editions.
121 pages. $3.00 *



A trilingual (English, French, Spanish) directory.
283 pages. $10.00 *



A manual on production and cost. English, French and Spanish editions.
90 pages, 36 ill. $3.00*

A response to the need for economic development in this zone to support a rapidly rising population. English, French and Spanish editions.
185 pages, 30 ill., 3 maps. $7.00 *

Available from tre Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy. For orders and information on prices in local currencies apply to any of the FAO Sales Agents and Booksellers listed on the inside back cover.

* Sales agents in all countries, including the United States, will establish local sales prices in accordance with local book-trade practices.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS